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Drought in recent years in the headwaters of the Rio Grande has caused stores in Elephant Butte Reservoir to wane. As of September 1, the reservoir is about five percent full, and irrigation water destined for 90,000 acres in southern New Mexico is completely exhausted. Irrigation next season will depend on winter precipitation, with increased groundwater pumping compensating for shortfalls in water allotments. Photo credit: Zack Guido, taken on July 10, 2012.

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

In this issue...

Feature Article

pg 3

Nearly of all the surface water in Elephant Butte Reservoir has been drained. For Greg Daviet, a pecan farmer in the Mesilla Valley outside Las Cruces, this means pumping more groundwater, an expensive alternative to surface water that can safeguard crops during drought.

Monsoon

pg 12

The monsoon has had its last gasp but delivered a wet summer to Arizona. Monsoon activity was far less vigorous in New Mexico, with most of the state experiencing below-average rainfall.

ENSO

pg 16

The march towards a possible El Niño event slowed this past month, but an El Niño is still likely to develop in coming months. The NOAA-Climate Prediction Center notes that the event will likely be weak at best and will not last long.

CLIMAS Climate Assessment for the Southwest

ARIZONA COOPERATIVE EXTENSION THE UNIVERSITY OF ARIZONA • COLLEGE OF AGRICULTURE AND LIFE SCIENCES

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September Climate Summary

Drought: Monsoon rainfall has brought some improvement to short-term drought conditions across Arizona and western New Mexico, but the entire Southwest continues to experience moderate or more severe drought, mostly due to longer-term deficits in precipitation.

Temperature: An active monsoon in the last 30 days helped lower temperatures in many areas in Arizona. In New Mexico, less copious rain contributed to above-average temperatures.

Precipitation: The monsoon has been a tale of two states. Many parts of Arizona experienced copious rain, while high pressure over New Mexico limited monsoon storms there.

ENSO: Neutral conditions were present again this past month, but a weak El Niño event is still forecast to develop in the next several months.

Climate Forecasts: Temperatures are expected to be slightly above average in coming months in the Southwest. It is unclear if precipitation will be above or below average.

The Bottom Line: Monsoon rains delivered much needed moisture for Arizona in the last three months, but left New Mexico wanting. The near constant presence of high humidity and copious rain in Arizona resulted in above-average precipitation in most of the state and helped improve short-term drought conditions. While all of Arizona is still experiencing moderate or a more extreme drought category, the amount of land classified with severe drought fell from 83 to 32 percent between June 15 and September 12. Precipitation, however, petered out just across the border in New Mexico, and drought conditions there remain more intense and widespread. Currently, about 73 percent of New Mexico is classified with severe drought, and in recent weeks a small sliver of exceptional drought developed in Curry and Roosevelt counties. In both states, longer-term drought impacts such as low water supplies remain widespread. The inflow into Lake Powell, for example, was the third lowest on record for the April and July period, and the combined storage in Lakes Mead and Powell is about 3 million acre-feet lower than one year ago. Also, Elephant Butte Reservoir, which supplies southern New Mexico's most productive agricultural region, stands at only 5 percent of capacity. Improvement in these longer-term drought impacts is hard to forecast at the moment. An El Niño event, which is forecast to develop in coming months but is expected to be weak and short lived, can bring above-average rain and snow to the southern tier of both states. Also, there is substantial precipitation variability during El Niño winters. These signs point toward the persistence of drought in the Southwest, but winter forecasts should become clearer in coming months.

Warmer Temperatures Pushing Plant Stress to the Extreme

When warmer temperatures like those experienced in recent years combine with periodic drought common to the American Southwest, plants pay the price. Warming that started in the late 1970s in the Southwest has produced fewer cool season freezes, losses in regional snowpack, an earlier onset of spring, and hotter summers. Another impact of regional warming is differential changes to climatic limits on plant growth across seasons and elevations, writes Jeremy Weiss, lead author on a peer-review study recently published in the *Journal of Geophysical Research Biogeosciences*. In the study, Weiss, a senior research specialist for the department of geosciences at the University of Arizona, and his co-authors compared growing conditions during the two major regional droughts of the 1950s and 2000s, the latter of which occurred during warmer times. Results from the study show that growing conditions during the 2000s drought reached extreme levels, especially for lower and middle elevations from spring through fall. These conditions were in large part spurred by the warmer temperatures, which created a feedback loop that led to drier and even warmer conditions. With global climate models projecting further regional warming in coming decades, the concern is that even more extreme growing conditions could occur during future drought periods.

For more information, visit: http://uanews.org/story/droughts-are-pushing-trees-limit

Table of Contents:

2 September 2012 Climate Summary
3 The Cost of Drought on the Rio Grande

Recent Conditions
5 Temperature
6 Precipitation
7 U.S. Drought Monitor
8 Arizona Drought Status
9 New Mexico Drought Status
10 Arizona Reservoir Levels
11 New Mexico Reservoir Levels
12 Monsoon Summary

Forecasts
13 Temperature Outlook
14 Precipitation Outlook
15 Seasonal Drought Outlook
16 El Niño Status and Forecast

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The Costs of Drought on the Rio Grande

By Zack Guido

This article is the second in a two-part series exploring effects of the current drought in New Mexico's Lower Rio Grande Valley and impacts to pecan farming. Part one discussed observed and expected changes in water supply and how regional water managers are responding.

Pecan trees bathe in irrigation water near Hatch, New Mexico, in July. Photo credit: Zack Guido

Nearly all of the surface water has been drained. The Rio Grande below New Mexico's Elephant Butte Reservoir is flowing at a trickle and sandy bars are now exposed where the chocolate-colored river had flowed only weeks ago. For Greg Daviet, a pecan farmer in the Mesilla Valley outside Las Cruces, the drone of groundwater pumps fills the air, and his wells spit crystalline water onto thirsty orchards.

Despite another dry year—the ninth time in the last decade that farmers received a fraction of the surface water they need to sustain their crops—the pecan trees are healthy thanks to bountiful groundwater that is drawn from wells to nourish the crop.

The extra pumping during the dry times, however, comes at a price. Groundwater costs more per acre-foot than surface water and is more harmful to crops. For Daviet and some other farmers in the region, the drought's toll is burdensome—but not bankrupting—and may force some creative measures to dampen the financial strain.

"The water is still sufficient in a drought, but how we [manage] it needs to change," Daviet said. "Drought will never be as profitable as wet times."

For other farms, the added expenses from continued dry conditions may push them to the brink.

Current Conditions

Back-to-back La Niña events during the 2010 and 2011 winters helped steer storms away from the Upper Rio Grande Basin in Colorado, where most of the water flowing in the Rio Grande originates. Rain and snow totaled less than 82 percent of the 1971–2000 average during those winters.

The scant precipitation has contributed to a decreasing trend in reservoir storage that began around 1999, and as of September 1, the region's largest reservoir—Elephant Butte—stood at less than 5 percent of capacity. The water available for future irrigation, doled out by the Elephant Butte Irrigation District (EBID), is now completely exhausted. For the foreseeable future, the amount of surface water available to farmers will depend entirely on the previous winter's precipitation and likely will be insufficient to meet demand. To compensate, irrigators will continue to rely heavily on groundwater.

"Around half a million acre-feet of water is the amount of water that needs to be put on the fields [in EBID]," Daviet said. "In wet years, the reservoirs provide plenty of that. In years when we are drier, we supplement that with groundwater pumping."

A Protective Shield

While Elephant Butte Reservoir stores water above ground, porous sediments below the Rio Grande form another, larger reservoir. The aquifer beneath Mesilla Valley is more than 2,000 feet thick in some places, providing ample water that safeguards farmers during droughts.

"It's a rather unique system we have here," said Phil King, professor of civil engineering at New Mexico State University and an EBID consultant. "The surface water and the groundwater are all the same water; they are closely linked. When there's plenty of surface water, the aquifer recharges. In times of drought, though, you have to go back and make withdrawals that deplete the groundwater that will be paid back by future surface water supplies. This allows the region to buffer wild fluctuations."

Groundwater not only protects trees from inadequate surface water allotments, it also allows farmers to apply water on demand. This is critical for ensuring productive crops and is needed even in times of copious surface water because bottlenecks arise in EBID deliveries. In the middle of the summer when demand is high, for example, EBID can move only a fraction of the water needed, and some farmers have to wait. In the absence of groundwater, these delays can stress the trees and ultimately reduce crop yields.

continued on page 4

The Costs of Drought continued

Even though groundwater pumping has ramped up in recent years, water levels have dropped only 30 feet after 10 years of drought, which doesn't worry some farmers or water managers.

"We are not in a long-term declining groundwater situation here," King said.

The Added Costs

Ample water and vibrant crops do not mean farmers are immune to drought. Rather than drying out their fields, the drought has shriveled their savings.

"When we have to pump nearly all of our water, for a pecan farmer it adds 10 to 15 percent to our normal expenditures," Daviet said.

These unwanted costs can skyrocket when large capital improvements need to be made to irrigation systems—added investments that occur more often in times of drought. When watering, Daviet needs to flood his fields with about 2,500 gallons per minute to quench the thirst of his trees. During a period year, he could pump only 1,900 gallons after one well failed and the lower water tables diminished his capacity in his other two wells.

"About every 10 feet that our water table drops, I lose about a 100 gallons per minute," Daviet said.

Daviet to spenr $150,000 on a new well, to overcome this shortfall, a significant portion of his operating budget. For profitable farms, these added expenditures can be absorbed. For farms functioning on the margins of profitability, it can push them over the edge.

"Big infrastructure improvements could be as much as 30 to 40 percent [of annual budgets] in years that big improvements need to be done to enable groundwater pumping," Daviet said. "When you are talking about that level of investment, if you have a farm that is marginal, that could be the straw that breaks them."

Young chili peppers sprout in Jim Lytle's fields in Hatch, New Mexico in early July. Photo credit: Zack Guido

The added costs affect more than pecan growers. In Hatch, about 40 miles north of Daviet's farm, the chili pepper is king. Jim Lytle and his family have been farming the valley since the late 1800s and have helped pioneer chili production in the region. A variety of pepper even cears the name of Lytle's father: the Big Jim. The drought has been a burden on his family as well.

"We use approximately four feet of water to irrigate one acre of chili," Lytle said. "We were only allocated [10] inches [this year], so the rest of it we have to pump. That's going to impact us significantly, and what it comes to is at the tail end we are going to make, probably, half of what we normally make."

Salty Soils

Groundwater also has other, hidden costs. Despite its translucent color—giving the impression of pure water—groundwater carries higher concentrations of salts and minerals than surface water.

"Those minerals and salts can be detrimental to the health of the trees," Daviet said.

The drought exacerbates salinity problems because increased groundwater pumping progressively draws water from deeper levels where salinity is enriched. It also pulls water from the fringes of the aquifer, where salts concentrate. In other words, the longer and more vigorously wells are pumped, the more saline the water becomes, eventually leading to saltier soils. This is particularly true near Hatch, where the aquifer is around a 100 feet thick.

"This is our fourth year of limited river water and so we're just fighting sodium in the soils," said Rosie Lack, sales executive for Lack Farms, which stretches over about 1,500 acres. "You can walk across the ground and it's like stepping on crackers."

In this region, fighting salinity is best waged with surface water, a difficult proposition when the resource is scarce. It is not impossible, however. It requires other coping strategies, including more coordinated management. Daviet, for example, can sell his surface water allocation to farms in Hatch in return for adequate financial compensation for the added expenditure of pumping more groundwater.

"We can work together to find solutions to these complex problems," Daviet said. "Drought is not the end of the world. We can adjust to it. We do adjust to it, as long as you don't fight change and try to adapt to it."

Temperature (through 9/19/12)

Data Source: High Plains Regional Climate Center

Temperatures since the water year began on October 1 reflect elevation and latitude, with northern regions cooler than southern areas and lower elevations warmer than higher elevations (*Figure 1a*). In northern areas, a few cold winter storms passed through the region, bringing cooler temperatures, while most of these storms missed southern portions of both states. Similar to the winter pattern, summer temperatures reflected latitude and elevation. Eastern New Mexico experienced the warmest conditions. Temperatures there were generally 1–4 degrees Fahrenheit above average, and these warm conditions were related to the lack of winter and summer storms—precipitation helps lower temperatures (*Figure 1b*). In Arizona, average temperatures during the water year were generally within 1 degree F of average, with the coldest areas in south-central Arizona.

In the past 30 days, the location of the subtropical high pressure controlled temperatures in the Southwest. The high remained over New Mexico, bringing cleat skies and warm temperatures, while Arizona enjoyed a southeasterly air flow that ferried moist air and delivered substantial cloudiness and cooler temperatures. Southern Arizona and the Mogollon Rim were about 2 degrees F cooler than average, while New Mexico was between 0 and 2 degrees F warmer than average (*Figures 1c–d*).

Figure 1a. Water year 2012 (October 1 through September 19) average temperature.

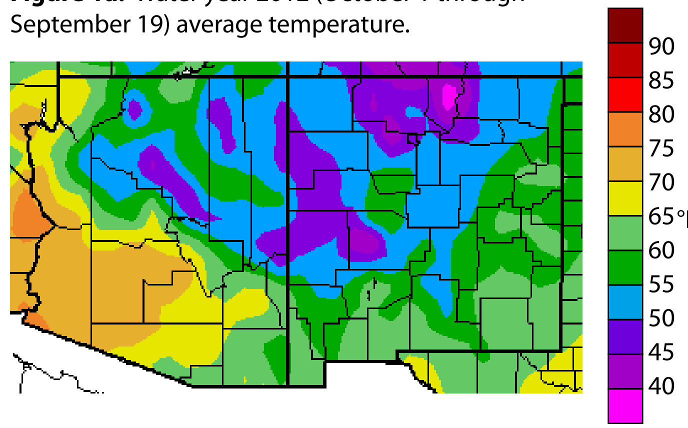


Figure 1b. Water year 2012 (October 1 through September 19) departure from average

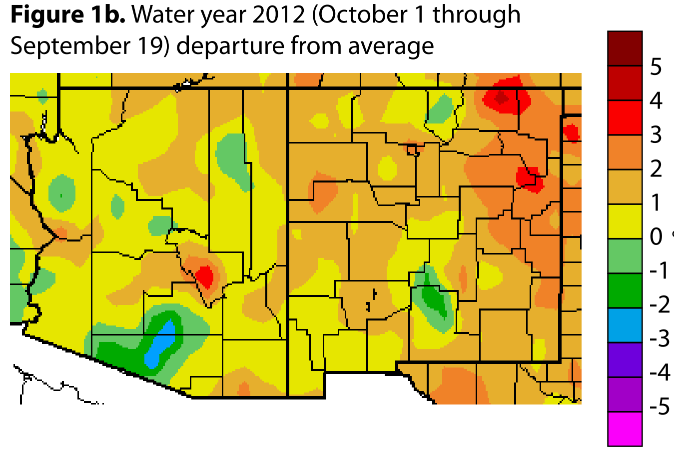


Figure 1c. Previous 30 days (August 21–September 19) departure from average temperature (interpolated).

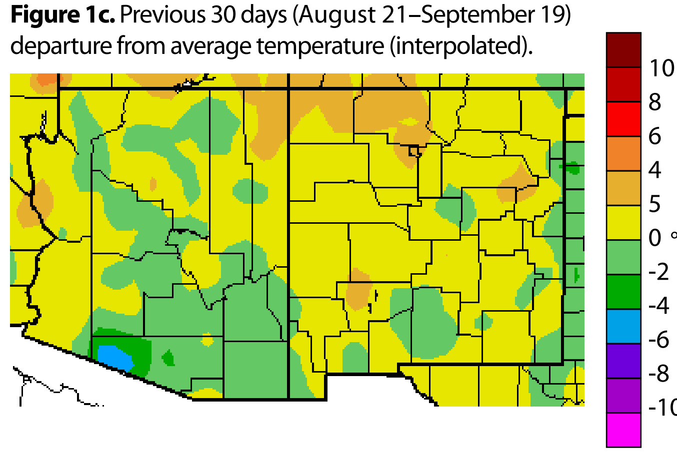
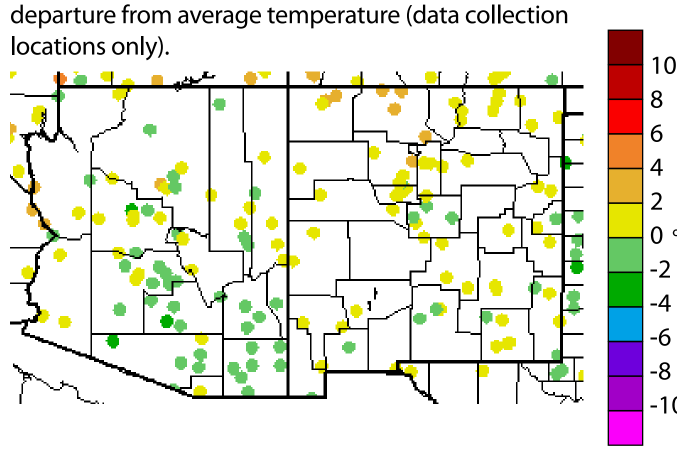


Figure 1d. Previous 30 days (August 21–September 19) departure from average temperature (data collection locations only).



Notes:

The water year begins on October 1 and ends on September 30 of the following year. As of October 1, 2011, we are in the 2012 Water year. Water year is more commonly used in association with precipitation; water year temperature can be used to measure the temperatures associated with the hydrological activity during the water year.

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

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

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

On the Web:

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

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

Precipitation (through 9/19/12)

Data Source: High Plains Regional Climate Center

Since the water year began on October 1, New Mexico and parts of Arizona have been much drier than average (*Figures 2a–b*). The La Niña circulation pattern, which helped deflect winter storms to the north, affected both states by reducing precipitation. New Mexico also experienced a below-average monsoon as a result of the position of the subtropical high—generally parked over New Mexico—which kept skies clear and brought little moisture to the state. Arizona, on the other hand, benefitted from the high pressure over New Mexico, as the position created southwesterly airflow that brought copious moisture into the state. The southern and eastern counties received average or above-average precipitation (see page 12). Even western Arizona, the driest area in the state, had a very active monsoon, with some intense storms. The vigorous monsoon helped compensate for precipitation deficits seen in much of Mohave County in the northeast and western Pima County in the south.

The last 30 days were a tale of two states. While Arizona received more than 200 percent of average rainfall over large parts of Arizona, reducing precipitation deficits from the dry winter and spring, New Mexico was relatively dry (*Figures 2c–d*). In Arizona, only a few isolated areas received below-average rainfall. New Mexico, on the other hand, only enjoyed rainfall over the higher elevations in the north and along the western border. The far northeastern counties received less than 50 percent of their average for this time of year.

Notes:

The water year begins on October 1 and ends on September 30 of the following year. As of October 1, 2011, we are in the 2012 water year. The water year is a more hydrologically sound measure of climate and hydrological activity than is the standard calendar year.

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

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

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

On the Web:

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

For National Climatic Data Center monthly state of the climate reports, visit http://www.ncdc.noaa.gov/sotc/

Figure 2a. Water year 2012 (October 1 through September 19) percent of average precipitation (interpolated).

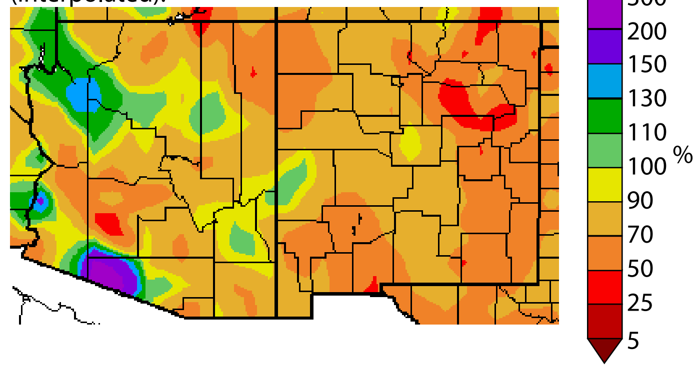


Figure 2b. Water year 2012 (October 1 through September 19) percent of average precipitation (data collection locations only).

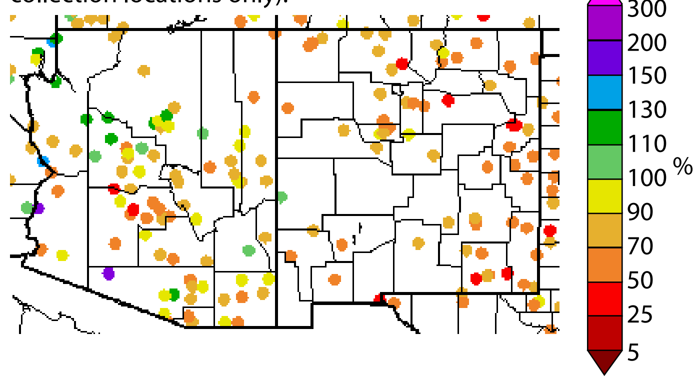


Figure 2c. Previous 30 days (August 21–September 19) percent of average precipitation (interpolated).

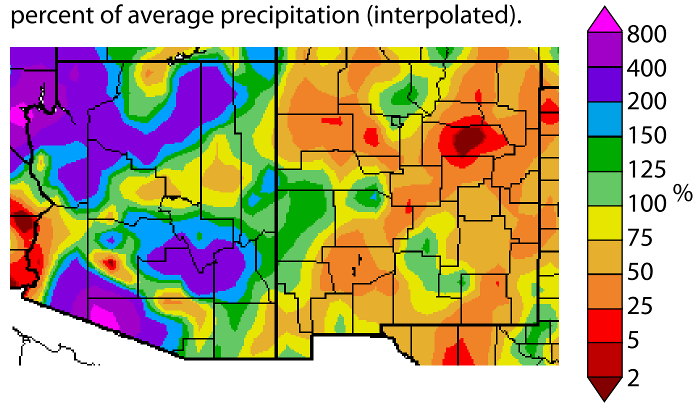
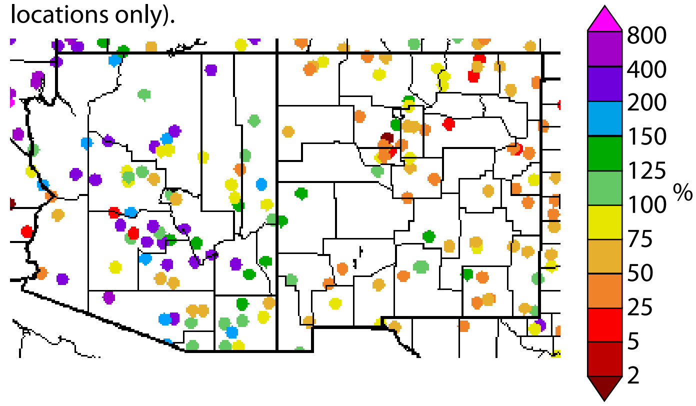


Figure 2d. Previous 30 days (August 21–September 19) percent of average precipitation (data collection locations only).



U.S. Drought Monitor (data through 9/18/12)

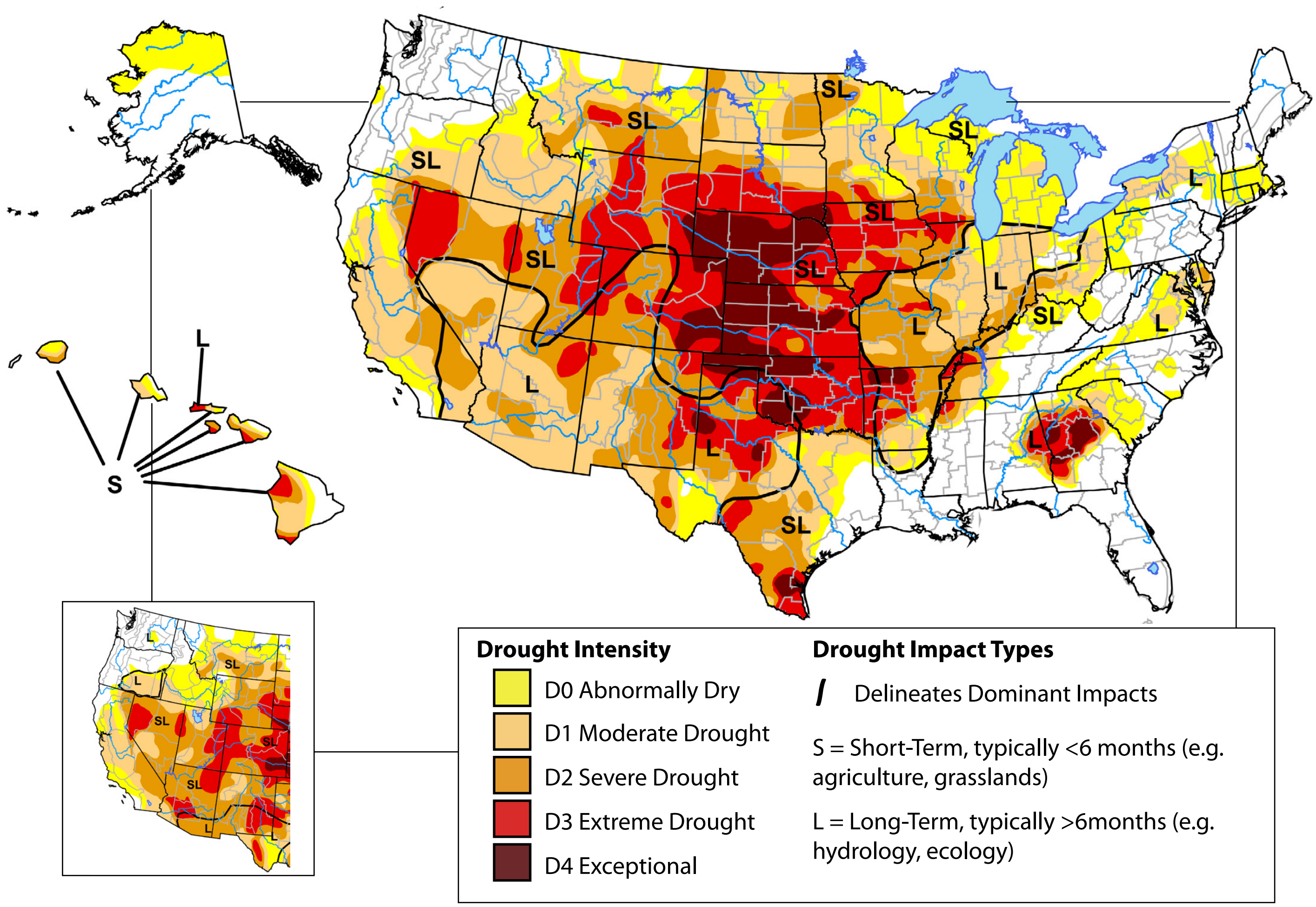
Data Sources: U.S. Department of Agriculture, National Drought Mitigation Center, National Oceanic and Atmospheric Administration

Drought conditions pushed north over the western U.S. during the past 30 days due to the persistence of hot and dry weather (*Figure 3*). Monsoon thunderstorms came to large swaths of Arizona, Nevada, and southern Utah, helping to beat back short-term drought conditions. These areas saw the most improvements in drought conditions. On the other hand, the largest expansion of drought occurred in the northern Rockies in Idaho and Montana, as moderate to severe drought expanded north to consume much of both states. Overall, 84 percent of the western U.S. is experiencing some level of drought; moderate or a more severe drought covers 76 percent.

Notes:

The U.S. Drought Monitor is released weekly (every Thursday) and represents data collected through the previous Tuesday. The inset (lower left) shows the western United States from the previous month's map. The U.S. Drought Monitor maps are based on expert assessment of variables including (but not limited to) the Palmer Drought Severity Index, soil moisture, streamflow, precipitation, and measures of vegetation stress, as well as reports of drought impacts. It is a joint effort of several agencies.

Figure 3. Drought Monitor data through September 18, 2012 (full size), and August 14, 2012 (inset, lower left).



On the Web:

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

Arizona Drought Status

(data through 9/18/12)

Data Source: U.S. Drought Monitor

Short-term drought conditions eased across most of Arizona over the past 30 days. However, all of Arizona continues to experience some level of drought, according to the September 18 update of the U.S. Drought Monitor (*Figures 4a–b*). Northeast and central Arizona are still observing severe to extreme drought; moderate drought covers the rest of the state. The area classified with severe or extreme drought fell from 93 percent in mid-August to 32 percent in mid-September. Plentiful monsoon rain over the past month helped drive this improvement in short-term drought conditions.

Figure 4a. Arizona drought map based on data through September 18.

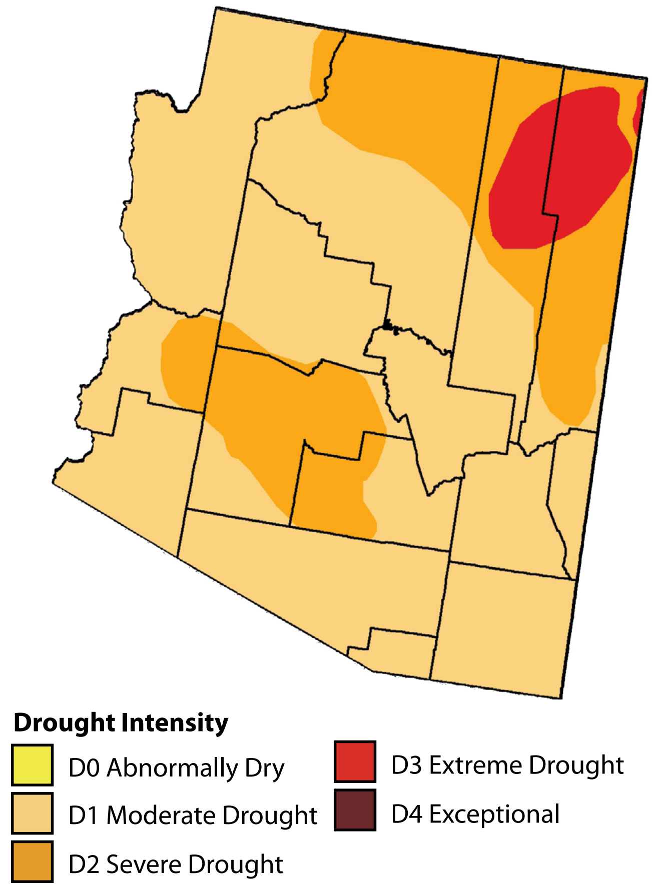


Figure 4b. Percent of Arizona designated with drought conditions based on data through September 18.

	Drought Conditions (Percent Area)					
	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	100.00	31.93	5.67	0.00
Last Week (09/11/2012 map)	0.00	100.00	100.00	32.65	6.89	0.00
3 Months Ago (06/19/2012 map)	0.00	100.00	100.00	93.72	24.60	0.00
Start of Calendar Year (12/27/2011 map)	16.70	83.30	60.34	36.56	2.78	0.00
Start of Water Year (09/27/2011 map)	0.02	99.98	69.76	42.81	15.34	1.67
One Year Ago (09/13/2011 map)	0.01	99.99	71.50	45.86	19.15	1.67

Notes:

The Arizona section of the U.S. Drought Monitor is released weekly (every Thursday) and represents data collected through the previous Tuesday. The maps are based on expert assessment of variables including (but not limited to) the Palmer Drought Severity Index, soil moisture, streamflow, precipitation, and measures of vegetation stress, as well as reports of drought impacts. It is a joint effort of several agencies.

On the Web:

For the most current drought status map, visit http://droughtmonitor.unl.edu/DM_state.htm?AZ,W

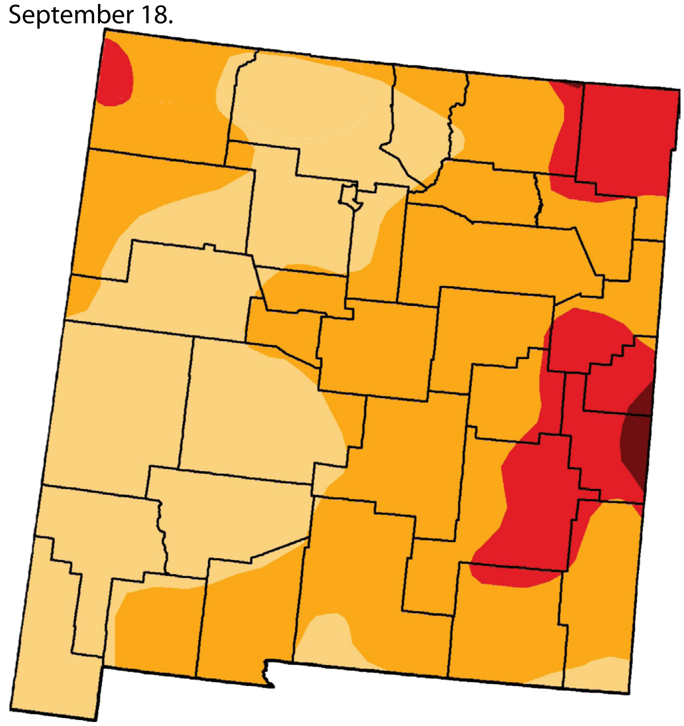
For monthly short-term and quarterly long-term Arizona drought status maps, visit http://www.azwater.gov/azdwr/StatewidePlanning/Drought/default.htm

New Mexico Drought Status
(data through 9/18/12)
Data Source: U.S. Drought Monitor

Short-term drought conditions improved slightly across parts of New Mexico during the past 30 days in response to decent monsoon thunderstorm activity. All of New Mexico continues to experience some level of drought, although conditions are improving in western parts of the state, according to the September 18 update of the U.S. Drought Monitor (*Figures 5a–b*). The rest of the state continues to observe severe to extreme drought conditions. A small area of exceptional drought, the highest level, has crept into Curry and Roosevelt counties. Overall, recent precipitation has caused the areas with at least severe drought to fall from 85 percent in mid-August to about 62 percent in mid-September.

The ongoing drought has hurt tourism in southern New Mexico in recent months (KFOX14, Sept. 3). Recreational visits to the Elephant Butte Reservoir were down this past Labor Day weekend due to low water levels in the reservoir. The reservoir is at only at about 5 percent of capacity, dampening the draw for camping and watersports at the recreation area.

Figure 5a. New Mexico drought map based on data through September 18.



Drought Intensity

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional

Figure 5b. Percent of New Mexico designated with drought conditions based on data through September 18.

	Drought Conditions (Percent Area)					
	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	100.00	62.56	12.25	0.66
Last Week (09/11/2012 map)	0.00	100.00	100.00	62.40	12.35	0.66
3 Months Ago (06/19/2012 map)	0.00	100.00	99.64	81.29	25.17	0.00
Start of Calendar Year (12/27/2011 map)	8.63	91.37	87.60	72.15	23.37	7.57
Start of Water Year (09/27/2011 map)	0.00	100.00	96.40	88.99	69.61	35.13
One Year Ago (09/13/2011 map)	0.00	100.00	100.00	89.33	72.20	38.22

Notes:

The New Mexico section of the U.S. Drought Monitor is released weekly (every Thursday) and represents data collected through the previous Tuesday. The maps are based on expert assessment of variables including (but not limited to) the Palmer Drought Severity Index, soil moisture, streamflow, precipitation, and measures of vegetation stress, as well as reports of drought impacts. It is a joint effort of several agencies.

This summary contains substantial contributions from the New Mexico Drought Working Group.

On the Web:

For the most current drought status map, visit http://droughtmonitor.unl.edu/DM_state.htm?NM,W

For the most current Drought Status Reports, visit http://www.nmdrought.state.nm.us/MonitoringWorkGroup/wk-monitoring.html

Arizona Reservoir Levels

(through 8/31/12)

Data Source: National Water and Climate Center

Combined storage in Lakes Mead and Powell is at about 54 percent of capacity, a decrease of 467,000 acre-feet during the last month (*Figure 6*). While this time of year usually experiences water storage declines, the 2012 April–July period this year recorded the third lowest streamflows since the closure of Glen Canyon Dam in 1963. Due to copious inflow that occurred in spring 2011, storage in the two reservoirs is still greater than it was two years ago when water levels in Lake Mead dipped to within about 15 feet, or about 1.5 million acre-feet, of triggering mandatory conservation measures.

Elsewhere in Arizona, combined storage is about 3 million acre-feet less than it was one year ago. Storage in San Carlos Reservoir slightly increased in August but remains low, at less than 1 percent of capacity as of September 1. Combined storage in the Salt and Verde river basin systems is 57 and 30 percent of capacity, respectively. While the Salt River Basin contains about as much water as it did one year ago, the Verde River Basin decreased by about 400,000 acre-feet.

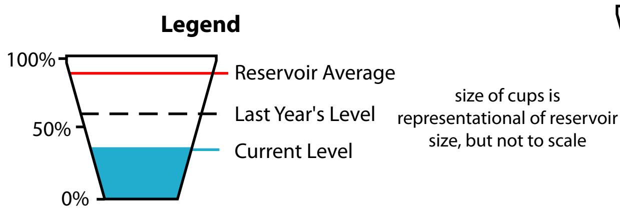
Notes:

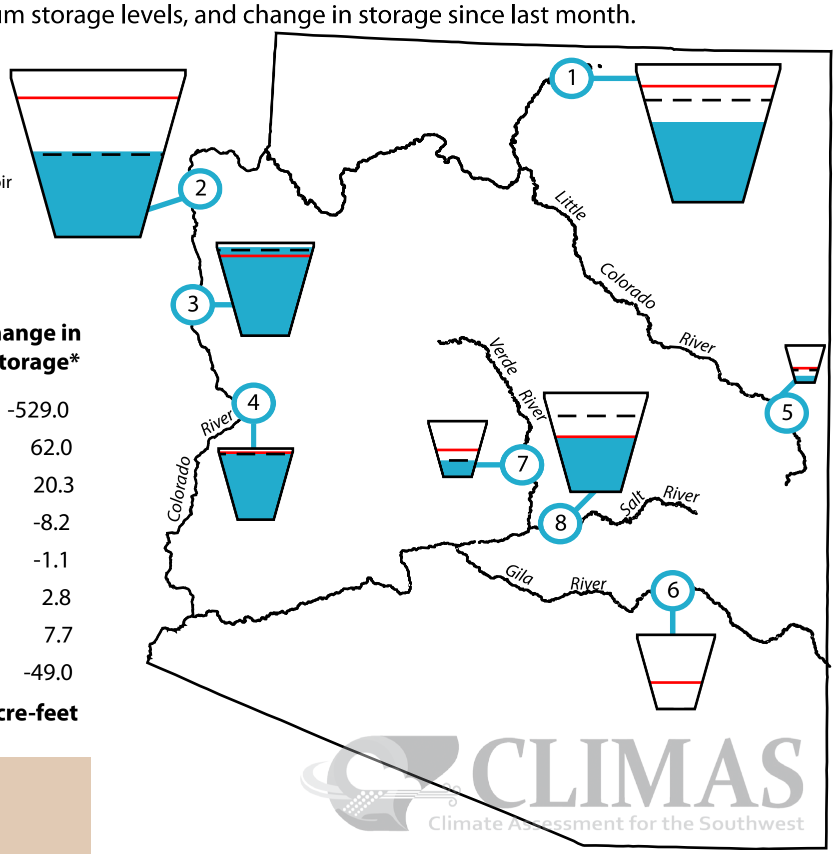
The map gives a representation of current storage levels for reservoirs in Arizona. Reservoir locations are numbered within the blue circles on the map, corresponding to the reservoirs listed in the table. The cup next to each reservoir shows the current storage level (blue fill) as a percent of total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

The table details more exactly the current capacity level (listed as a percent of maximum storage). Current and maximum storage levels are given in thousands of acre-feet for each reservoir. One acre-foot is the volume of water sufficient to cover an acre of land to a depth of 1 foot (approximately 325,851 gallons). On average, 1 acre-foot of water is enough to meet the demands of four people for a year. The last column of the table list an increase or decrease in storage since last month. A line indicates no change.

These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS).

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





Reservoir Name	Capacity Level	Current Storage*	Max Storage*	Change in Storage*
1. Lake Powell	58%	14,151.0	24,322.0	-529.0
2. Lake Mead	51%	13,269.0	26,159.0	62.0
3. Lake Mohave	95%	1,716.0	1,810.0	20.3
4. Lake Havasu	95%	589.5	619.0	-8.2
5. Lyman Reservoir	18%	5.3	30.0	-1.1
6. San Carlos	1%	4.4	875.0	2.8
7. Verde River System	30%	86.7	287.4	7.7
8. Salt River System	57%	1,163.2	2,025.8	-49.0

*** thousands of acre-feet**

On the Web:

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

New Mexico Reservoir Levels
(through 8/31/12)

Data Source: National Water and Climate Center

New Mexico reservoirs that have reported this month show a combined water storage decrease of about 191,000 acre-feet in July (*Figure 7*). Cochiti Lake and Abiquiu were the only New Mexico reservoirs tracked here that increased storage during August. Storage in Navajo, New Mexico's largest reservoir, stands at 65 percent of average. On the other hand, Elephant Butte and Caballo reservoirs, located on the Rio Grande in central New Mexico, lost about 74,000 acre-feet and are only 5 percent full. Despite reduced irrigation allotments in nine out of the last 10 years, irrigation water in these two reservoirs is completely exhausted. This water helps support 90,000 acres of farmland, predominantly in Doña Ana County, and shortfalls during recent years—and those of the future—have been offset by increased groundwater pumping that bears an economic burden for farmers (see Page 3). Low precipitation stemming from the extended and severe La Niña episodes during the past two winters reduced runoff to streams feeding many reservoirs in New Mexico.

Notes:

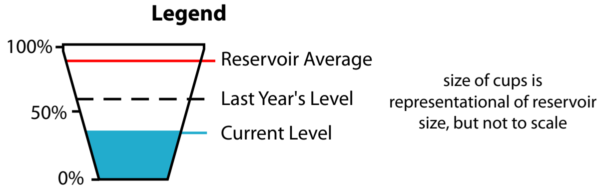
The map gives a representation of current storage levels for reservoirs in New Mexico. Reservoir locations are numbered within the blue circles on the map, corresponding to the reservoirs listed in the table. The cup next to each reservoir shows the current storage level (blue fill) as a percent of total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

The table details more exactly the current capacity level (listed as a percent of maximum storage). Current and maximum storage levels are given in thousands of acre-feet for each reservoir. One acre-foot is the volume of water sufficient to cover an acre of land to a depth of 1 foot (approximately 325,851 gallons). On average, 1 acre-foot of water is enough to meet the demands of four people for a year. The last column of the table list an increase or decrease in storage since last month. A line indicates no change.

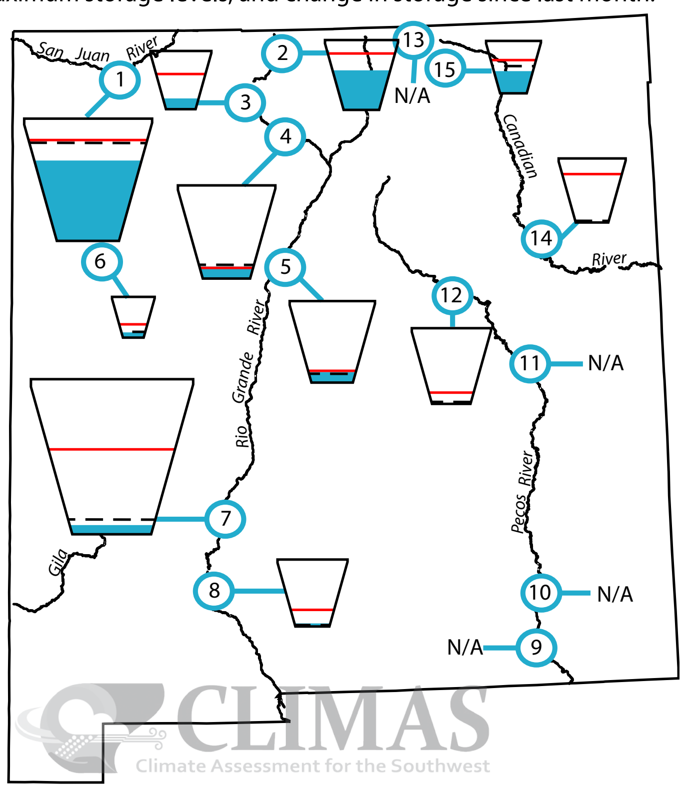
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS).

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

Legend



Reservoir Name	Capacity Level	Current Storage*	Max Storage*	Change in Storage*
1. Navajo	65%	1,100.5	1,696.0	-75.4
2. Heron	56%	222.4	400.0	-35.1
3. El Vado	18%	34.7	190.3	-2.4
4. Abiquiu	12%	147.6	1,192.8	0.4
5. Cochiti	11%	53.0	491.0	1.8
6. Bluewater	11%	4.1	38.5	-0.7
7. Elephant Butte	5%	111.8	2,195.0	-65.6
8. Caballo	4%	12.7	332.0	-8.0
9. Lake Avalon	N/A	N/A	4.0	N/A
10. Brantley	N/A	N/A	1008.2	N/A
11. Sumner	N/A	N/A	102.0	N/A
12. Santa Rosa	1%	4.7	438.3	-1.7
13. Costilla	N/A	N/A	16.0	N/A
14. Conchas	2%	4.8	254.2	-2.4
15. Eagle Nest	41%	32.1	79.0	-2.0



*** thousands of acre-feet**

N/A cooresponds to reservoirs that did not report storage values this month

On the Web:

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

Monsoon Summary
(through 9/12/2012)

Data Source: Western Regional Climate Center

High water content was present in the atmosphere for most of the monsoon in Arizona, which has been the pattern in recent years. The dew point temperature, which is a measure of water in the atmosphere, was predominantly at levels that favored storms across Arizona this summer. As a result, most of the state experienced an active 2012 monsoon, particularly southern areas and the Mogollon Rim, which received above-average rain (*Figure 8a*). Rain in many parts of these regions measured between 6.5 and 8.5 inches between June 15 and September 12 (*Figure 8b*), with the greatest departures from average occurring in western Arizona (*Figure 8c*). In this region, several surges from the Gulf of California helped fuel intense storms. Yuma, for example, received 2.25 inches of rain—0.96 inches more than average. High moisture content and other favorable conditions led to rainfall that measured 6.02 and 3.00 inches at the Tucson and Phoenix airports, respectively, which is 0.37 and 0.29 inches above their historical average. While the position of the subtropical high pressure, which was centered predominantly over New Mexico, allowed moist air to waft into Arizona from the southeast, it also prevented incursions of damp air into New Mexico. There, the high pressure brought clear, cloudless skies for much of the monsoon, and nearly all of the state received below-average rainfall. Many parts of eastern New Mexico received less than 70 percent of their historical average. While the dry conditions did not expand drought conditions in New Mexico in the last three months, they also did not help improve conditions. Currently, nearly all of eastern New Mexico is experiencing severe and extreme drought (see page 9).

Figure 8a. Total precipitation in inches (June 15–September 12, 2012).

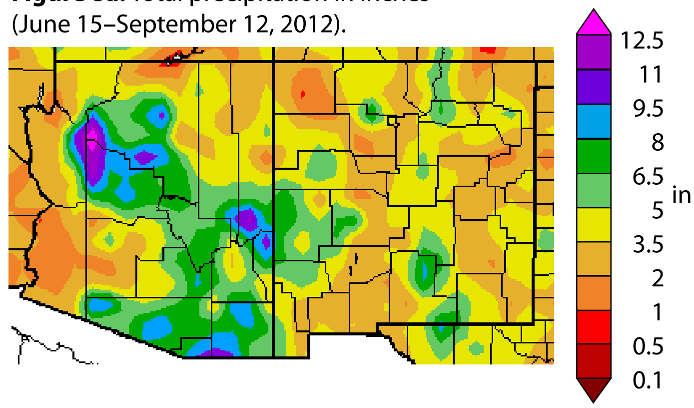


Figure 8b. Departure from average precipitation in inches (June 15–September 12, 2012).

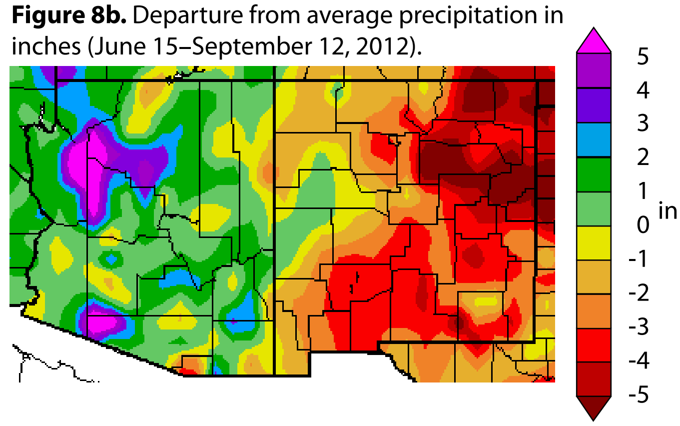
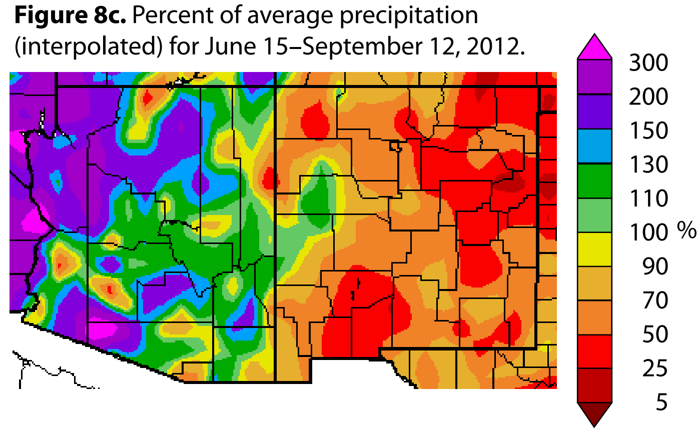


Figure 8c. Percent of average precipitation (interpolated) for June 15–September 12, 2012.



Notes:

The continuous color maps (figures above) 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.

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

On the Web:

These data are obtained from the National Climatic Data Center:
http://www.hprcc.unl.edu/maps/current/

Temperature Outlook
(October 2012–March 2013)
Data Source: NOAA-Climate Prediction Center (CPC)

The seasonal temperature outlooks issued by the NOAA-Climate Prediction Center (NOAA-CPC) in September call for slightly increased chances that temperatures will be similar to the warmest 10 years in the 1981–2010 period for the October–December and November–January seasons (*Figures 9a–b*). Recent warming trends during these periods influence the forecasts. In the three-month seasons that follow, forecasts call for equal chances for above-, below-, or near-average conditions in Arizona and New Mexico (*Figures 9c–d*). Contributing to these forecasts is the uncertainty surrounding whether an El Niño event will form and what its ultimate strength will be (see page 16). This affects temperature because El Niño events often deliver increased precipitation in the Southwest that also, consequently, brings cooler temperatures. While forecasts currently indicate the formation of an El Niño event, confidence in the fate of the event should grow in coming months.

Notes:

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

The NOAA-CPC outlooks are a 3-category forecast. As a starting point, the 1981–2010 climate record is divided into 3 categories, each with a 33.3 percent chance of occurring (i.e., equal chances, EC). The forecast indicates the likelihood of one of the extremes—above-average (A) or below-average (B)—with a corresponding adjustment to the other extreme category; the "average" category is preserved at 33.3 likelihood, unless the forecast is very strong.

Thus, using the NOAA-CPC temperature outlook, areas with light brown shading display a 33.3–39.9 percent chance of above-average, a 33.3 percent chance of average, and a 26.7–33.3 percent chance of below-average temperature. A shade darker brown indicates a 40.0–50.0 percent chance of above-average, a 33.3 percent chance of average, and a 16.7–26.6 percent chance of below-average temperature, and so on.

Equal Chances (EC) indicates areas where no forecast skill has been demonstrated or there is no clear climate signal; areas labeled EC suggest an equal likelihood of above-average, average, and below-average conditions, as a "default option" when forecast skill is poor.

Figure 9a. Long-lead national temperature forecast for October–December 2012.

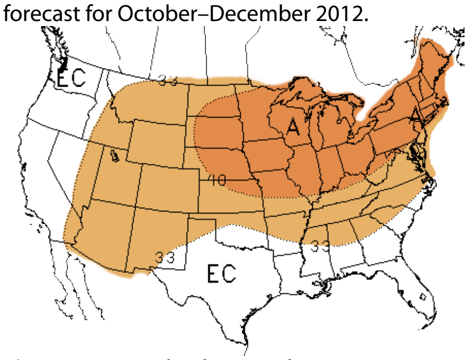


Figure 9b. Long-lead national temperature forecast for November 2012–Jaunary 2013.

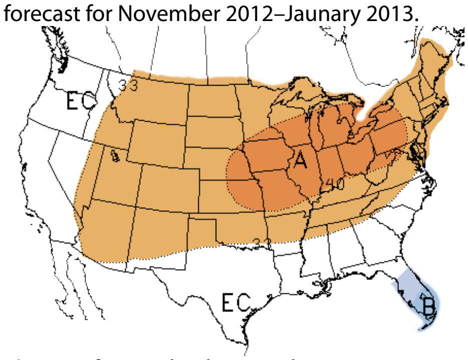


Figure 9c. Long-lead national temperature forecast for December 2012–February 2013.

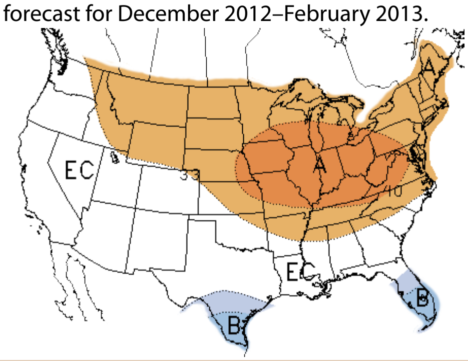
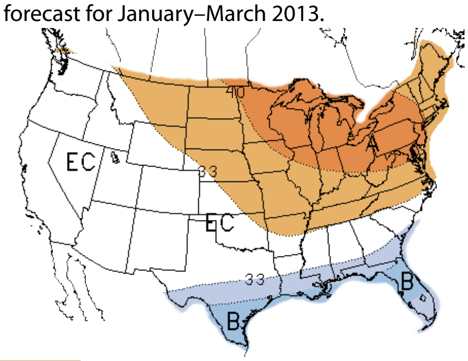


Figure 9d. Long-lead national temperature forecast for January–March 2013.



A= Above: 50.0–59.9%; 40.0–49.9%; 33.3–39.9%

B=Below: 40.0–49.9%; 33.3–39.9%

EC= Equal chances. No forecasted anomalies.

On the Web:

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

For seasonal temperature forecast downscaled to the local scale, visit http://www.weather.gov/climate/l3mto.php

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

Precipitation Outlook
(October 2012–March 2013)

Data Source: NOAA-Climate Prediction Center (CPC)

The seasonal precipitation outlooks issued by the NOAA-Climate Prediction Center (NOAA-CPC) in September call for equal chances that precipitation during the October–December period will be above-, below-, or near average (*Figure 10a*). During this time, topical hurricane activity can deliver copious rain to the region, but these events are difficult to predict. In subsequent three-month seasons, an El Niño event, which is forecast to materialize in coming months, will likely bring wetter-than-average conditions to southern parts of the Southwest (*Figures 10b–d*). Increased precipitation in the Southwest during El Niño events is caused by an enhancement of the subtropical jet, which helps deliver more moisture to the region. However, while an El Niño event is still likely to develop, the CPC notes that it will likely be weak and short-lived (see page 16).

Notes:

These outlooks predict the likelihood (chance) of above-average, average, and below-average precipitation, but not the magnitude of such variation. The numbers on the maps do not refer to inches of precipitation.

The NOAA-CPC outlooks are a 3-category forecast. As a starting point, the 1981–2010 climate record is divided into 3 categories, each with a 33.3 percent chance of occurring (i.e., equal chances, EC). The forecast indicates the likelihood of one of the extremes—above-average (A) or below-average (B)—with a corresponding adjustment to the other extreme category; the "average" category is preserved at 33.3 likelihood, unless the forecast is very strong.

Thus, using the NOAA-CPC precipitation outlook, areas with light green shading display a 33.3–39.9 percent chance of above-average, a 33.3 percent chance of average, and a 26.7–33.3 percent chance of below-average precipitation. A shade darker green indicates a 40.0–50.0 percent chance of above-average, a 33.3 percent chance of average, and a 16.7–26.6 percent chance of below-average precipitation, and so on.

Equal Chances (EC) indicates areas where no forecast skill has been demonstrated or there is no clear climate signal; areas labeled EC suggest an equal likelihood of above-average, average, and below-average conditions, as a "default option" when forecast skill is poor.

Figure 10a. Long-lead national precipitation forecast for October–December 2012.

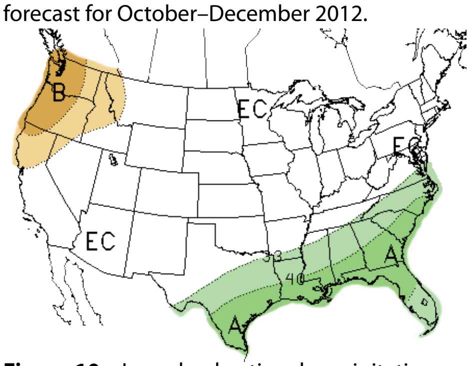
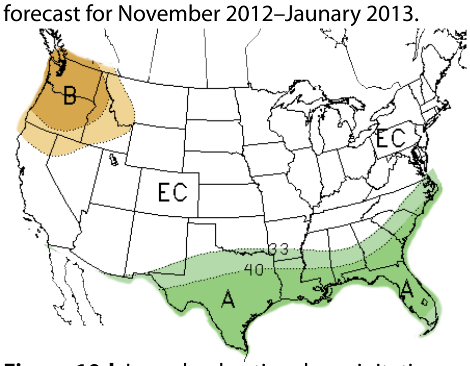


Figure 10b. Long-lead national precipitation forecast for November 2012–Jaunary 2013.



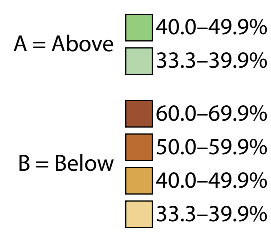


Figure 10c. Long-lead national precipitation forecast for December 2012–February 2013.

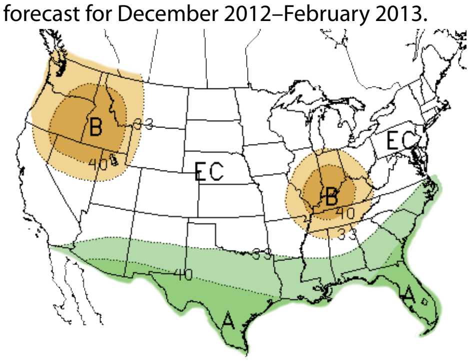
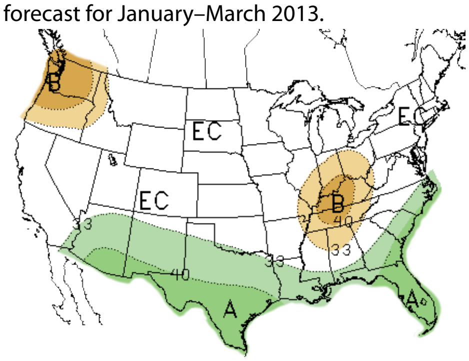


Figure 10d. Long-lead national precipitation forecast for January–March 2013.



EC = Equal chances. No forecasted anomalies.

On the Web:

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

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

Seasonal Drought Outlook
(through December)

Data Source: NOAA-Climate Prediction Center (CPC)

This summary is partially excerpted and edited from the September 20 Seasonal Drought Outlook technical discussion produced by the NOAA-Climate Prediction Center (CPC) and written by forecaster B. Pugh.

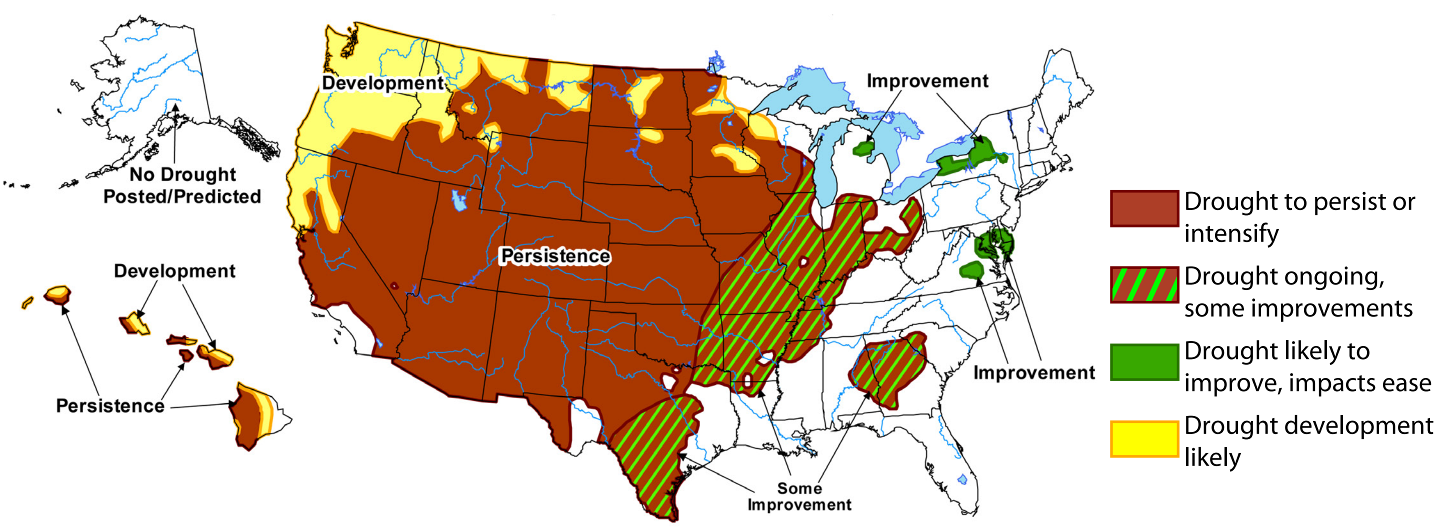
As the monsoon nears its end, drought conditions are expected to persist in the southwest (*Figure 11*). Although localized improvement is possible with rainfall during late September and the beginning of October, widespread improvement is not expected. Drought persistence is also forecast for the central Rocky Mountains, where most forecast decision support indicators—such as temperature and precipitation outlooks for the October–December period and El Niño precipitation anomalies—suggest low precipitation. Despite these indicators, the NOAA-CPC assigns a low confidence in the forecasts for both the Southwest and the central Rockies.

Elsewhere in the West, forecast confidence is higher. Dry weather accompanied by unseasonably warm temperatures during the first half of September affected the Pacific Northwest. For upcoming weeks and months, decision support tools indicate increased chances for below-median precipitation. This includes composites from El Niño events; an El Niño is expected to develop in the next few months. As a result, the persistence of current drought and the possibility for the development of drought is forecast for the Pacific Northwest and northern California, and the NOAA-CPC assigns a high confidence in this forecast.

Notes:

The delineated areas in the Seasonal Drought Outlook are defined subjectively and are based on expert assessment of numerous indicators, including the official precipitation outlooks, various medium- and short-range forecasts , models such as the 6-10 day and 8-14 day forecasts, soil moisture tools, and climatology.

Figure 11. Seasonal drought outlook through December (released September 20).



On the Web:

For more information, visit http://www.drought.gov/portal/server.pt

For medium- and short-range forecasts, visit http://www.cpc.ncep.noaa.gov/products/forecasts/

For soil moisture tools, visit http://www.cpc.ncep.noaa.gov/soilmst/forecasts.shtml

El Niño Status and Forecast

Data Sources: NOAA-Climate Prediction Center (CPC), International Research Institute for Climate and Society (IRI)

The march towards a possible El Niño event slowed this past month as sea surface temperatures (SSTs) held steady and even cooled in some areas across the equatorial Pacific Ocean. An El Niño Watch issued several months ago by the NOAA-Climate Prediction Center (CPC) remains in effect this month, meaning that El Niño conditions may still develop in the next several months. Mixed signals across the equatorial Pacific Ocean include a slight cooling of SSTs and weak atmospheric circulation pattern shifts—the Southern Oscillation Index is only slightly negative (*Figure 12a*)—but widespread warmer-than-average water just below the surface indicates the steady progression towards the El Niño event observed over the past several months has slowed.

Official forecasts issued jointly by the CPC and the International Research Institute for Climate and Society (IRI) still depict a strong chance (82 percent) that El Niño conditions will develop sometime in the September–November period (*Figure 12b*). This is up slightly from the 78 percent chance forecast last month for the same time period. The chance of El Niño conditions developing is quite high relative to the chance of current neutral conditions persisting (18 percent). Regardless, the event is forecast to be weak at best and is expected to quickly wane in the late winter season. The CPC notes that this may limit the impact that El Niño conditions have on the upcoming winter circulation. A weaker forecast of above-average winter precipitation across the Southwest that is limited to far southern portions of Arizona and New Mexico (see page 14). Conditions in the Pacific Ocean will continue to change over the next 30 days, and forecasts will continue to be adjusted; confidence in the ultimate fate of the El Niño event will grow in coming months.

Notes:

The first figure shows the standardized three month running average values of the Southern Oscillation Index (SOI) from January 1980 through August 2012. The SOI measures the atmospheric response to SST changes across the Pacific Ocean basin. The SOI is strongly associated with climate effects in the Southwest. Values greater than 0.5 represent La Niña conditions, which are frequently associated with dry winters and sometimes with wet summers. Values less than -0.5 represent El Niño conditions, which are often associated with wet winters.

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

Figure 12a. The standardized values of the Southern Oscillation Index from January 1980–August 2012. La Niña/El Niño occurs when values are greater than 0.5 (blue) or less than -0.5 (red), respectively. Values between these thresholds are relatively neutral (green).

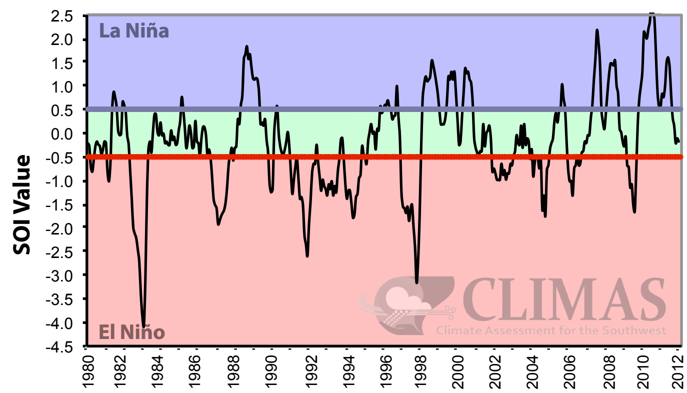
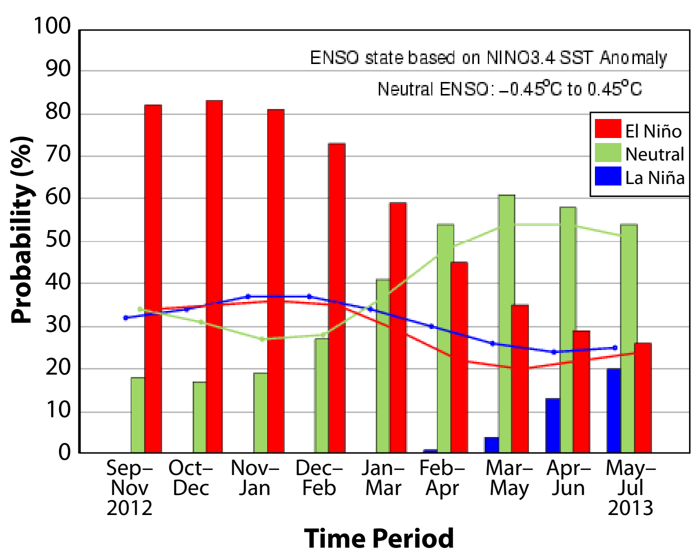


Figure 12b. IRI probabilistic ENSO forecast for El Niño 3.4 monitoring region (released September 20). Colored lines represent average historical probability of El Niño, La Niña, and neutral conditions.



On the Web:

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

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