Contributors

Ben McMahan
SWCO Editor; Research, Outreach & Assessment Specialist (CLIMAS)

Mike Crimmins
UA Extension Specialist

Stephanie Doster
Institute of the Environment Editor

Dave Dubois
New Mexico State Climatologist

Gregg Garfin
Founding Editor and Deputy Director of Outreach, Institute of the Environment

Nancy J. Selover
Arizona State Climatologist

Published by the Climate Assessment for the Southwest (CLIMAS), with support from University of Arizona Cooperative Extension, the Arizona State Climate Office, and the New Mexico State Climate office.

November Southwest Climate Outlook

Precipitation & Temperature: October precipitation totals were below average across most of the climate divisions in Arizona and New Mexico, except for parts of western Arizona and central New Mexico (Fig. 1a). October temperatures were much above average across all of the two states, with record-warm observations in southern and eastern New Mexico (Fig. 1b). November precipitation to date has been buoyed by storm events that pushed in as part of a cutoff low. This rainfall may boost the percent of average precipitation calculations to impressive numbers, but the actual amount of rain that has fallen has been relatively meager (Fig. 2). In terms of regional climate, November tends to be one of the drier months. November temperatures have continued the trend observed in October ("Hot-tober"), ranging from 2 to 8 degrees F above normal across most of Arizona and New Mexico, a pattern that extends across the Intermountain West (Fig. 3).

Snowpack & Water Supply: Warm temperatures across the western United States in October and November resulted in early season snowpack and snow water equivalent (SWE) values that are much below average across most of the West. As of November 16, a majority of the stations recorded below 25 percent of average SWE (Fig. 4). A few stations in Arizona and New Mexico have seen recent snow activity, but given persistent high temperatures, it remains to be seen how long this snow will remain. There is ongoing concern that continued western drought conditions may lead to water supply restrictions. For more information, see reservoir storage on p. 7.

Drought: Long-term drought conditions persist across the Southwest (Fig. 5). According to the U.S. Drought Monitor, most of Arizona is designated as abnormally dry (D0) or experiencing moderate drought (D1). The far southwestern corner of the state is designated as experiencing severe drought (D2), reflecting the persistent multi-year drought conditions extending from central and Southern California. In New Mexico, most of the northern half of the state, along with pockets along the U.S.-Mexico border, are designated as abnormally dry (D0).

ENSO & La Niña: The current outlook for La Niña is not particularly definitive. Borderline weak La Niña conditions persist, and these conditions likely will remain through much of winter 2017. However, models and forecasts continue to identify a rapid decline of La Niña conditions in early 2017, which may limit the influence of La Niña on weather in the Southwest. That said, the climate of the Southwest is inherently dry (i.e., winter is characterized by relatively low precipitation totals in a normal year), and La Niña conditions are more likely than not to increase the chances of a drier-than-average winter. This continues to raise concern given the multi-year drought currently underway in the Southwest and the possibility of water restrictions in coming years if Lake Mead forecasts drop below the 1,075-foot elevation threshold.

Precipitation & Temperature Forecasts: The November 17 NOAA Climate Prediction Center's outlook for December calls for equal chances of above- or below-average precipitation and increased chances of above-average temperatures. The three-month outlook for December through February calls for increased chances of below-average precipitation (Fig. 6, top) and increased chances of above-average temperatures (Fig. 6, bottom).

Tweet Nov SW Climate Outlook CLICK TO TWEET

NOV2016 @CLIMAS_UA SW Climate Outlook - Climate Summary, La Niña Tracker, Water Year in Review, Reservoir Volumes http://bit.ly/2fM3SSj

Online Resources

Figure 1
National Center for Environmental Information
https://www.ncdc.noaa.gov

Figures 2-3
High Plains Regional Climate Center
http://www.hprcc.unl.edu/

Figure 4
Western Regional Climate Center
http://www.wrcc.dri.edu/

Figure 5
U.S. Drought Monitor
http://droughtmonitor.unl.edu/

Figure 6
NWS Climate Prediction Center
http://www.cpc.ncep.noaa.gov/

CLIMAS YouTube Channel

Visit our YouTube channel for videos of content pulled from the podcast.

www.youtube.com/user/UACLIMAS/

Podcasts

Visit our website or iTunes to subscribe to our podcast feed.

www.climas.arizona.edu/media/podcasts

November Southwest Climate Outlook

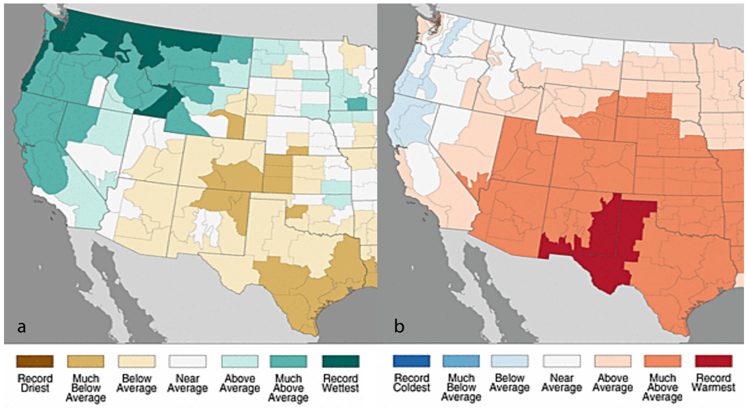


Figure 1: Oct 2016 Precipitation (a) & Temperature Ranks (b)

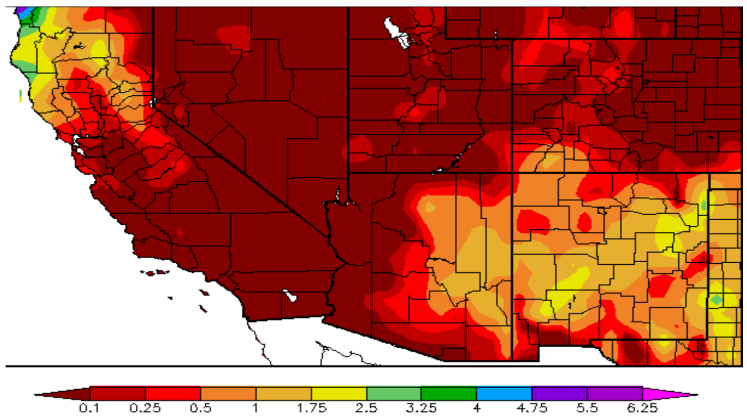


Figure 2: Observed Precipitation November 2016

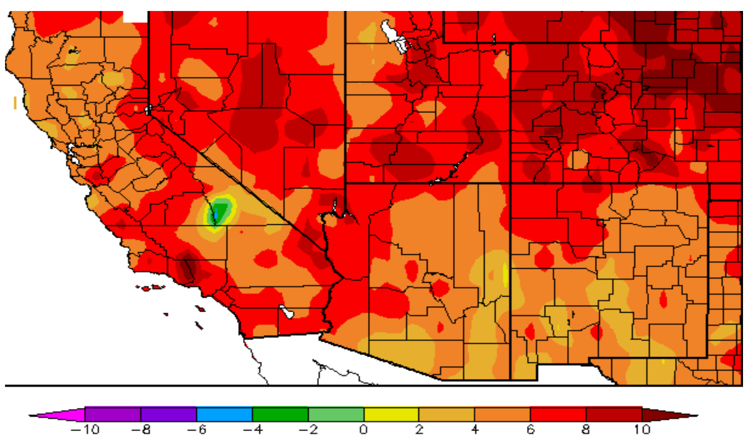


Figure 3: Departure from Normal Temperature November 2016

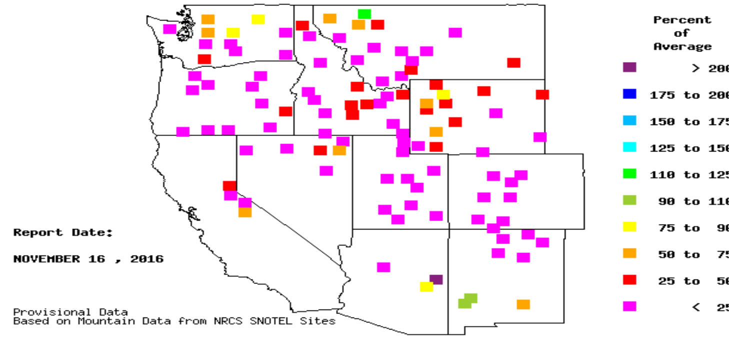


Figure 4: Basin Percent of Average Snow Water Content

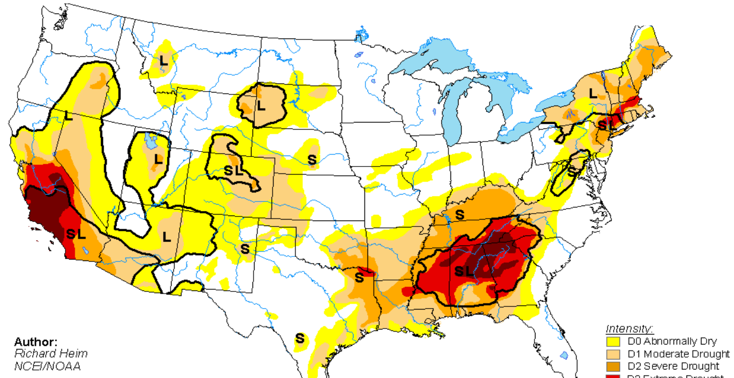


Figure 5: US Drought Monitor - Nov 15, 2016

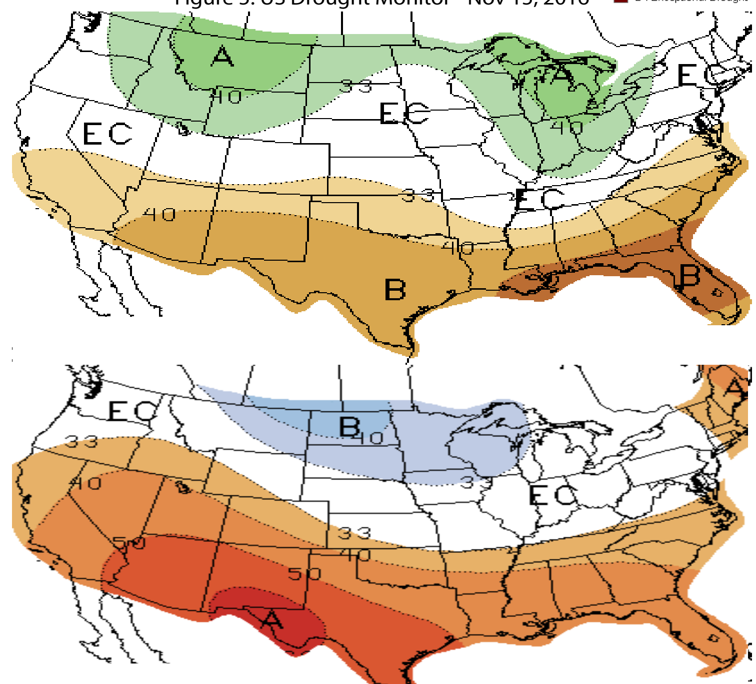


Figure 6: Three-Month Outlook - Precipitation (top) & Temperature (bottom) - Nov 17 2016

Online Resources

Figure 1
Australian Bureau of Meteorology
http://www.bom.gov.au/climate/enso/index.shtml

Figure 2
NOAA - National Climatic Data Center
http://www.ncdc.noaa.gov/teleconnections/enso/

Figure 3
International Research Institute for Climate and Society
http://iri.columbia.edu/our-expertise/climate/forecasts/enso/

Figure 4
NOAA - Climate Prediction Center
http://www.cpc.ncep.noaa.gov/

El Niño

Information on this page is also found on the CLIMAS website:

www.climas.arizona.edu/sw-climate/el-niño-southern-oscillation

El Niño Southern Oscillation - La Niña

Oceanic and atmospheric indicators of the El Niño-Southern Oscillation (ENSO) continue to indicate the likelihood of a weak La Niña event this winter (Figs. 1-2), although the chance of an ENSO-neutral winter cannot be ruled out. Any hedging in the forecasts and outlooks likely stems from uncertainty as to whether the event will maintain even weak La Niña strength through winter 2017 (December–February). Fluctuations in forecasts and models are likely due to the limited coordination between oceanic and atmospheric conditions described in previous outlooks, as well as generally borderline conditions (i.e., between weak La Niña and ENSO-neutral).

A closer look at the forecasts and seasonal outlooks continues to provide some insight into the range of expectations for a La Niña event this winter. On November 8, the Australian Bureau of Meteorology maintained its La Niña watch with a 50 percent chance of La Niña forming this winter—twice the normal likelihood—but also cautioned that La Niña events have only developed this late in the calendar year once since 1980. On November 10, the Japanese Meteorological Agency identified the ongoing presence of La Niña conditions in the equatorial Pacific and maintained its projection of a 60 percent chance of La Niña lasting through winter compared to a 40 percent chance of a return to ENSO-neutral conditions. Also on November 10, the NOAA Climate Prediction Center (CPC) identified ongoing weak La Niña conditions. The CPC indicated this event had a 55 percent chance of lasting through winter 2017 but that, generally speaking, it is expected to be short lived, with consensus focused on the event ending during or by the end of winter 2017. On November 17, the International Research Institute for Climate and Society (IRI) and CPC forecasts identified the emergence of a weak La Niña event that was likely to weaken further over the winter, and that would take very little to knock it out of La Niña status ("hanging on by a couple of toothpicks" according to Tony Barnston at IRI). The weak signal and uncertain future is captured in the Mid-Nov forecast that identifies a just over 50 percent chance of La Niña lasting through winter 2017, but with a rapid decline by spring 2017 (Fig. 3). The North American multi-model ensemble (NMME) characterizes the current model spread and highlights the variability looking forward to 2017. The NMME mean remains in the weak-to-borderline La Niña category through 2016 before returning to neutral conditions in early 2017 (Fig. 4).

(continued on next page)

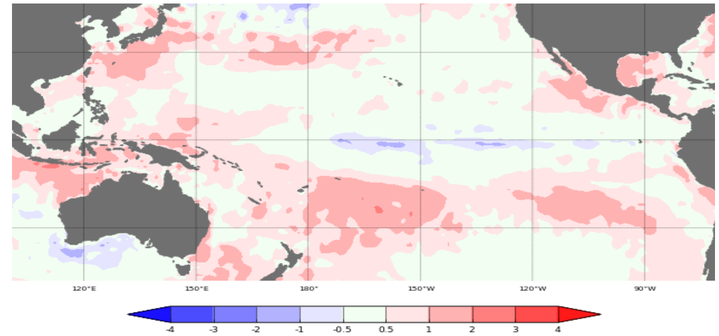


Figure 1: October 2016 Sea Surface Temperature (SST) Anomalies

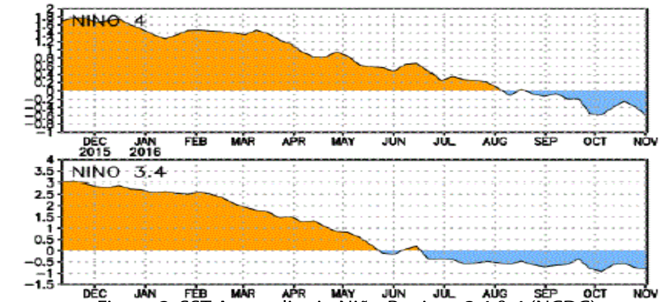


Figure 2: SST Anomalies in Niño Regions 3.4 & 4 (NCDC)

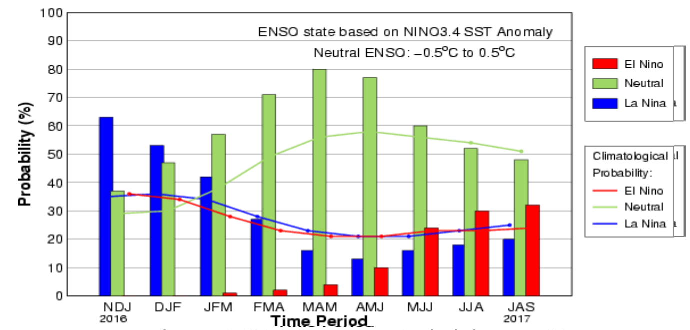


Figure 3: Mid-Nov IRI/CPC Consensus Probabilistic ENSO Forecast

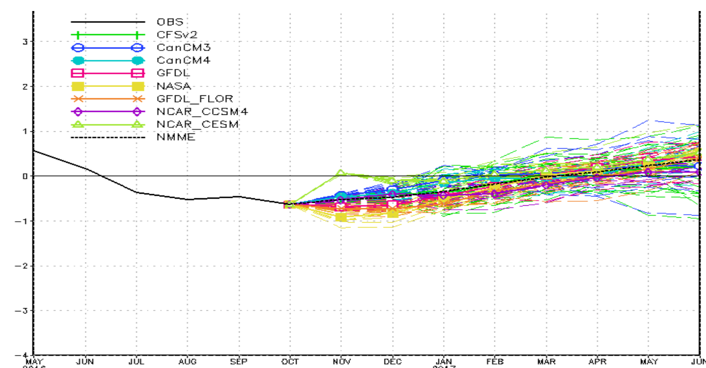


Figure 4: North American Multi-Model Ensemble Forecast for Niño 3.4

Online Resources

Figure 5
Climate Science Applications Program
http://cals.arizona.edu/climate

Figures 6a-6b
NOAA - Climate Prediction Center
http://www.cpc.ncep.noaa.gov/

El Niño

Information on this page is also found on the CLIMAS website:

www.climas.arizona.edu/sw-climate/el-niño-southern-oscillation

El Niño Southern Oscillation - La Niña - continued

La Niña remains on the horizon for the Southwest in winter 2017, with current forecasts indicating a weak La Niña event during winter 2016–2017, which is more likely than not to bring warmer- and drier-than-average conditions to the region over the cool season. Even if the event decays more rapidly than forecast and conditions tack back toward neutral conditions, borderline La Niña conditions still could affect temperature and precipitation patterns through the winter. Southwestern winters already are characterized by a relatively dry climate (i.e., limited precipitation events over the cool season), and a La Niña event has the potential to shift that seasonal pattern to an even drier state. While considerable variability exists in precipitation totals during ENSO-neutral years, La Niña years tend to cluster on the dry end of the distribution (Fig. 5). Seasonal forecasts likely were already incorporating the influence of La Niña into monthly and seasonal forecasts, and if La Niña does persist, even in a weak form, we can expect these forecasts will continue to suggest warmer- and drier-than-average conditions (Figs. 6a-b).

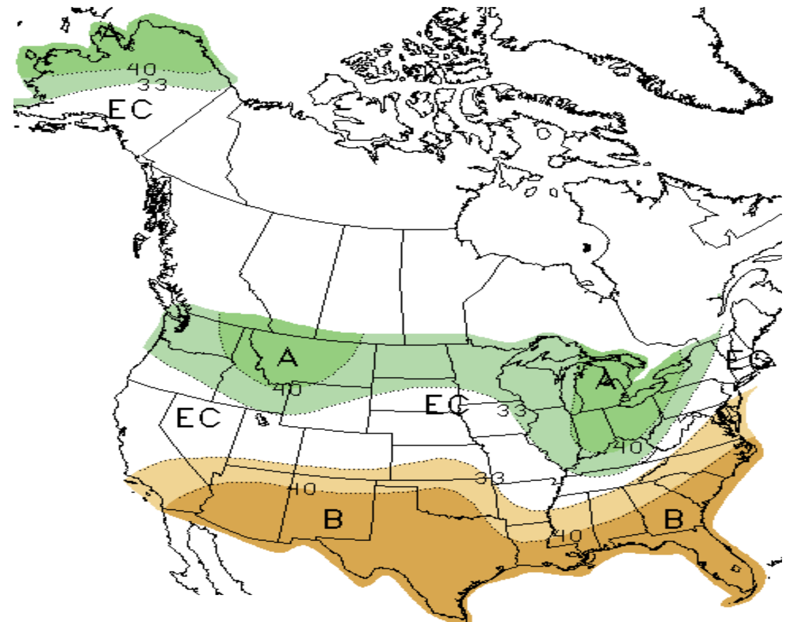


Figure 6a: Three-Month Precipitation Outlook Jan 2016 - Mar 2017

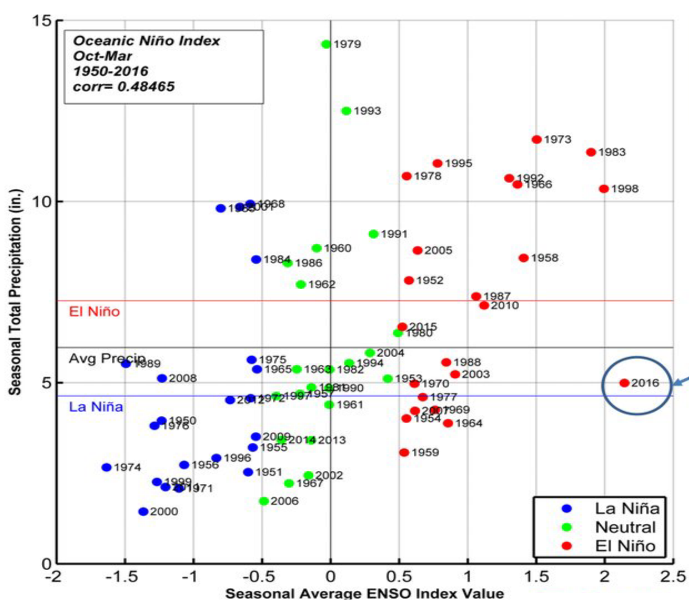


Figure 5: Arizona Climate Division 7 - ENSO vs. Precipitation

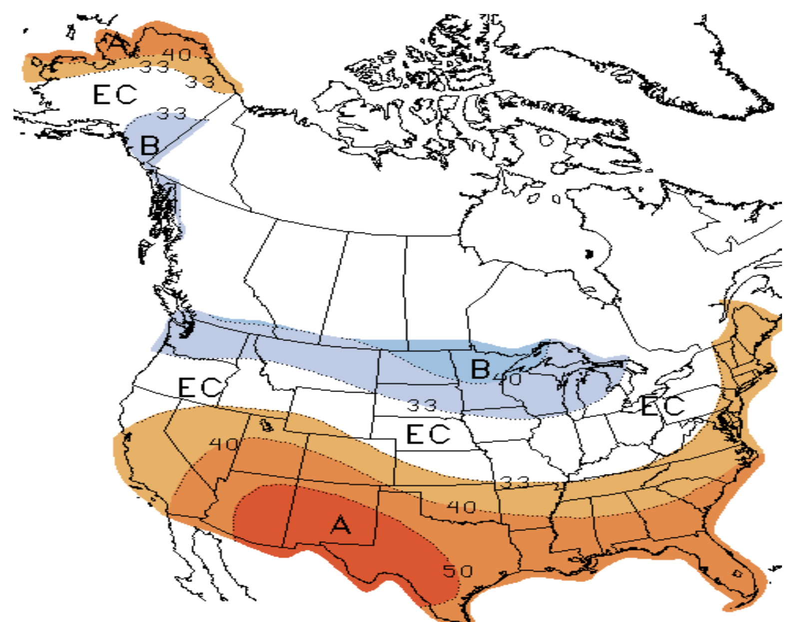


Figure 6b: Three-Month Temperature Outlook Jan 2016 - Mar 2017

Online Resources

Figure 1
West Wide Drought Tracker
http://www.wrcc.dri.edu/wwdt

Figures 2-3
High Plains Regional Climate Center
http://www.hprcc.unl.edu/

Water Year in Review

Water year precipitation (October 1, 2015 to September 30, 2016) was below average in much of the Southwest, particularly in Southern California, most of southern Arizona, and western New Mexico, and average to above average in northern Arizona and eastern New Mexico (Fig. 1). Spatial representations of cumulative water year precipitation adequately characterize the overall distribution of above- and below-average precipitation totals, but they do little to document the month-by-month accumulation of precipitation. This can be important, as heavy precipitation events such as tropical storm activity or monsoon events can quickly boost yearly totals, but with a lesser contribution to long-term water storage (as water from extreme events is lost to evaporation and runoff).

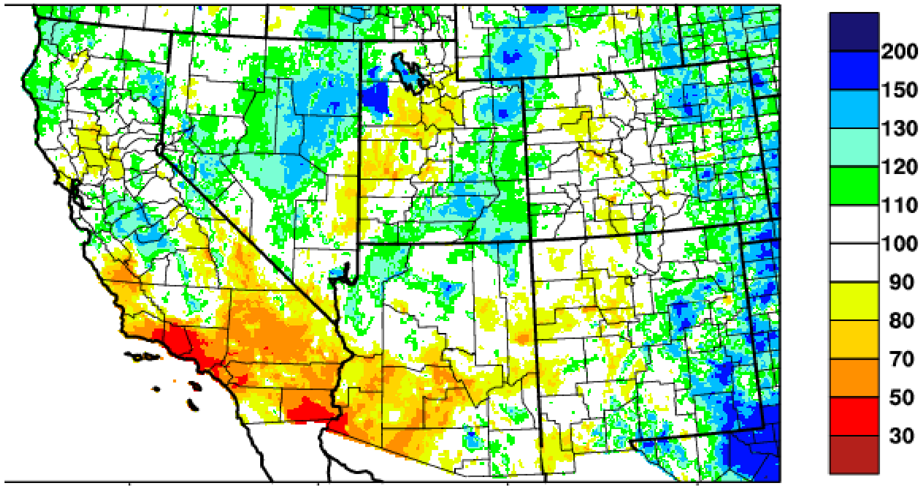


Figure 1: Percent of Normal Precipitation Oct 1 2015 - Sep 30 2016

The Show Low Municipal Airport weather station (Fig. 2) is an example in which the monthly accumulation (green) stuck rather closely to the normal accumulation, with a number of winter storms bringing the cool-season total very close to average by May 1, and then typical monsoon events bringing the seasonal cumulative total very close—albeit just shy—of the expected normal. A few of the stations that recorded above-normal cumulative totals reveal other patterns. The Flagstaff Pulliam station (Fig. 3) recorded very close to normal cool-season precipitation (October 1 to May 1), but above-normal monsoon activity helped push the seasonal total above average. The Las Cruces (NMSU) weather station (Fig. 4) recorded a fairly normal monsoon and numerous events that brought above-average conditions over the cool season, resulting in above-average seasonal totals. The El Paso International Airport station (Fig. 5) recorded both above-average cool-season and monsoon precipitation. Of those stations that recorded below-average precipitation, some saw relatively normal cool-season precipitation but below-average monsoon precipitation (Fig. 6). Other stations recorded relatively typical monsoon precipitation but were starting at a deficit coming out of the cool season (Fig. 7).

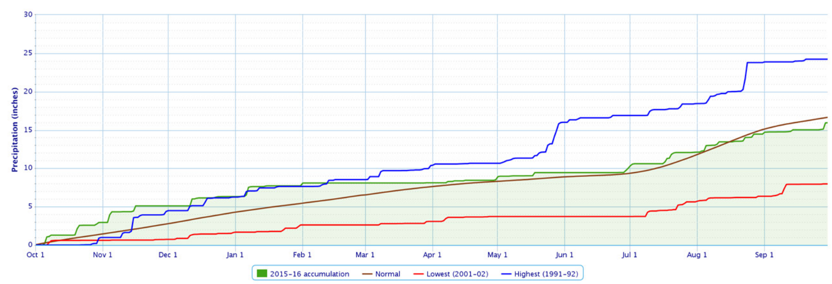


Fig 2: Accumulated Precipitation Oct 1 2015 - Sept 30 2016 - Show Low Muni AP, AZ

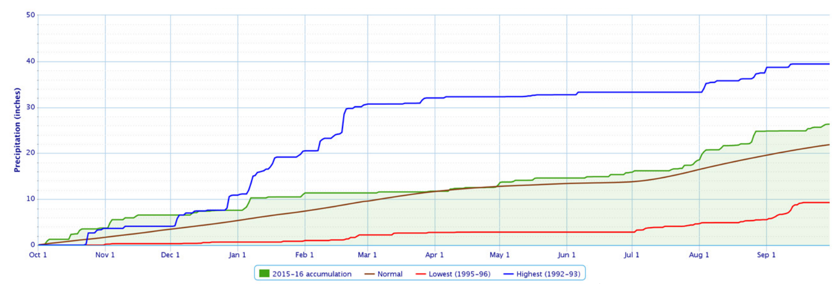


Fig 3: Accumulated Precipitation Oct 1 2015 - Sept 30 2016 - Flagstaff Pulliam, AZ

Online Resources

Figures 4-7
High Plains Regional Climate Center
http://www.hprcc.unl.edu/

Water Year in Review

So what's the point? Water year precipitation is just one of the metrics we use to assess drought and water supply. As has been discussed at length, a week of heavy monsoon activity or a direct hit from a tropical storm, while they tend to boost seasonal and water year totals, may do less to help with long-term drought than we would hope.

Looking back at El Niño and the winter of 2015–2016, this is one of the reasons why so much hope was pinned on that event, and why so much disappointment resulted when it performed so poorly in the Southwest. Sustained and soaking winter precipitation that builds snowpack at higher elevations while it soaks into the ground in the lower elevation deserts and rangeland is one of the more effective ways the region might start to bounce back from sustained multi-year droughts. Looking forward to winter 2016-2017, the seasonal outlooks show the influence of La Niña conditions, (i.e. warmer- and drier-than-average conditions over winter), suggesting decreased chances of winter preciptation events that are crucial to the region in terms of drought and water resources managment.

Other Resources

USGS Arizona Water Science Center
http://az.water.usgs.gov/

USGS New Mexico Water Science Center
http://nm.water.usgs.gov/

Univ. of Arizona Water Resources Research Center
https://wrrc.arizona.edu/

New Mexico Water Resources Research Institute
https://nmwrri.nmsu.edu/

Arizona Dept of Water Resources
http://www.azwater.gov/azdwr/

New Mexico Office of the State Engineer
http://www.ose.state.nm.us/WR/

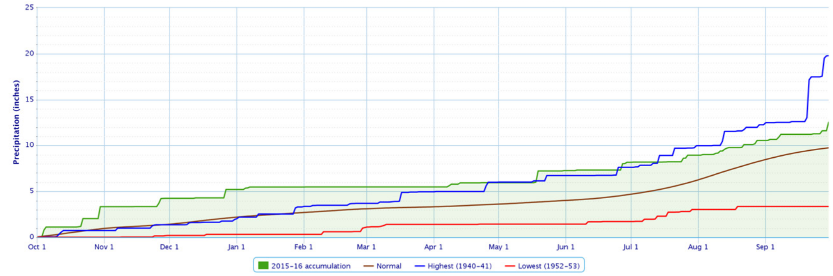


Fig 4: Accumulated Precipitation Oct 1 2015 - Sept 30 2016 - NMSU (Las Cruces), NM

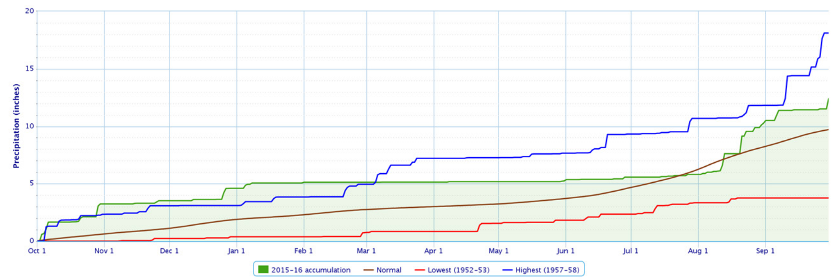


Fig 5: Accumulated Precipitation Oct 1 2015 - Sept 30 2016 - El Paso Intl AP, TX

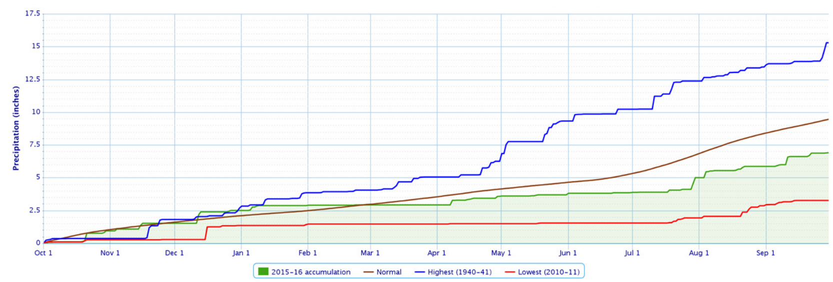


Fig 6: Accumulated Precipitation Oct 1 2015 - Sept 30 2016 - Albuquerque Intl AP, NM

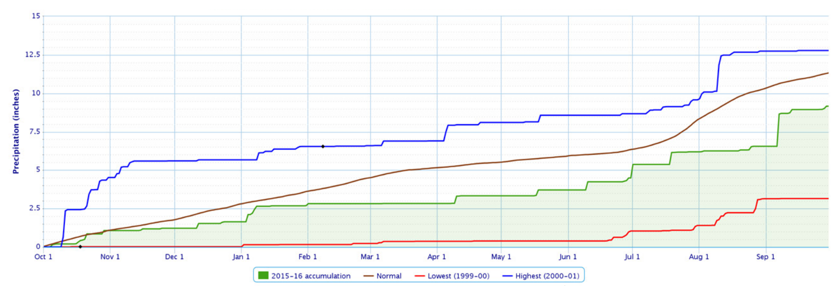


Fig 7: Accumulated Precipitation Oct 1 2015 - Sept 30 2016 - Safford Muni AP, AZ

Online Resources

Portions of the information provided in this figure can be accessed at the Natural Resources Conservation Service

Arizona: http://1.usa.gov/19e2BdJ

New Mexico: http://www.wcc.nrcs.usda.gov/cgibin/resv_rpt.pl?state=new_mexico

We updated our 'max storage' values for numerous NM reservoirs based on conservation storage vs. maximum flood capacity. This altered the percent capacity calculations, even while 'current storage' numbers are unchanged.

Contact Ben McMahan with any questions or comments about these or any other suggested revisions.

Notes

The map gives a representation of current storage for reservoirs in Arizona and 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 (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 (dotted line) and the 1981–2010 reservoir average (red line).

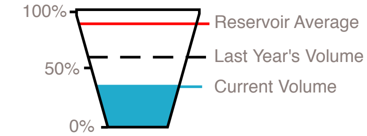
The table details more exactly the current capacity (listed as a percent of maximum storage). Current and maximum storage are given in thousands of acre-feet for each reservoir. One acre-foot is the volume of water sufficient to cover an acre of land to a depth of 1 foot (approximately 325,851 gallons).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

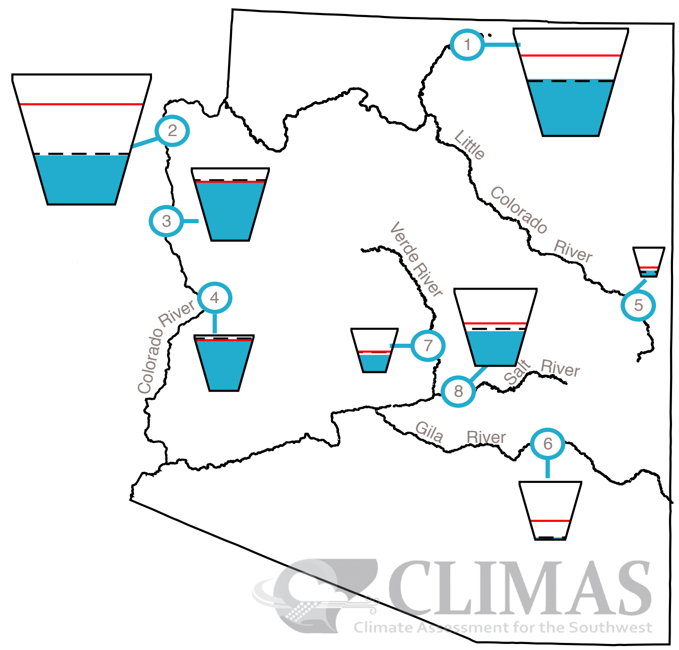
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS).

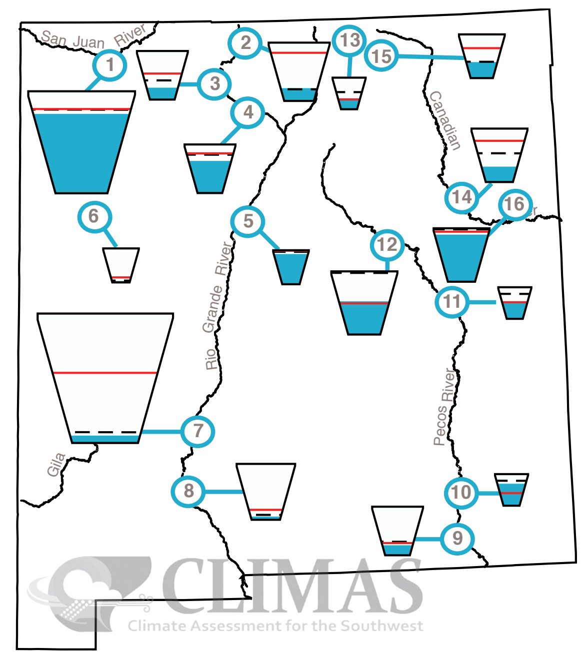
Reservoir Volumes

DATA THROUGH OCT 31, 2016

Data Source: National Water and Climate Center, Natural Resources Conservation Service







Reservoir	Capacity	Current Storage*	Max Storage*	One-Month Change in Storage*
1. Lake Powell	53%	12,828.2	24,322.0	6.1
2. Lake Mead	37%	9,709.0	26,159.0	87.0
3. Lake Mohave	82%	1,479.0	1,810.0	-145.0
4. Lake Havasu	91%	561.7	619.0	-19.8
5. Lyman	20%	6.1	30.0	-0.8
6. San Carlos	3%	22.1	875.0	6.2
7. Verde River System	40%	115.7	287.4	-14.2
8. Salt River System	45%	910.8	2,025.8	-25.8

*KAF: thousands of acre-feet

Reservoir	Capacity	Current Storage*	Max Storage*	One-Month Change in Storage*
1. Navajo	77%	1,300.1	1,696.0	-9.7
2. Heron	22%	88.1	400.0	-4.6
3. El Vado	24%	45.0	190.3	-1.8
4. Abiquiu	66%	122.4	186.8**	-2.5
5. Cochiti	89%	44.7	50.0**	-0.7
6. Bluewater	4%	1.6	38.5	0.0
7. Elephant Butte	6%	128.7	2,195.0	-3.4
8. Caballo	5%	16.2	332.0	10.7
9. Lake Avalon	20%	0.9	4.5**	-0.4
10. Brantley	70%	29.6	42.2**	-7.4
11. Sumner	48%	17.3	102.0**	-5.1
12. Santa Rosa	53%	56.1	105.9**	-0.8
13. Costilla	29%	4.6	16.0	0.4
14. Conchas	28%	71.8	254.2	-10.6
15. Eagle Nest	38%	29.6	79.0	-1.3
16. Ute Reservoir	88%	176	200	-2.0