Contributors

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

Mike Crimmins
UA Extension Specialist

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

Betsy Woodhouse
Institute of the Environment

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.

March Southwest Climate Outlook

Precipitation & Temperature: February precipitation totals were average to above average in Arizona and ranged from below to above average in New Mexico (Fig. 1a). February temperatures were much-above average across most of region, including record warmest temperatures in eastern New Mexico (Fig. 1b). March precipitation to date has been dry across the Southwest, reversing the wet trends of early winter (Fig. 2a). March temperatures have also been above average across the Southwest (Fig. 2b), including a run of near-record temperatures at the time of this writing. Water-year precipitation and temperature are both above average across much of the Southwest (Fig. 3).

Snowpack & Water Supply: After an impressive run of storms during January and February, activity has tapered and temperatures continue to rise. Snowpack and snow water equivalent (SWE) are both generally well-above average across much of the Intermountain West (Fig. 4). The extent to which persistent above-average temperatures affect water storage dynamics across the West (e.g., rain vs. snow, storage, evaporation, runoff, infiltration, etc.) remains to be seen, although streamflow forecasts remain optimistic for above-average flow. Water managers and drought experts are keeping a close watch on potential changes to streamflow timing given its possible implications for water storage, ecology, and drought.

Drought: The storms this winter (and since the water year began on Oct. 1) have resulted in a significant scaling back of drought designations across most of the West. California in particular has seen marked improvement. Southern Arizona (extending into Southern California) and northeastern New Mexico have the remaining pockets of drought in the Southwest, designated as either abnormally dry (D0) or in moderate drought (D1) (Fig. 5). It is important to note that while short-term events have scaled back drought designations, the Southwest has been in drought for most of the last 15 years, so it remains to be seen if this recovery holds and brings long-term improvements to reservoir storage, agricultural and range conditions, wildfire risk, and ecological drought.

Environmental Health & Safety: Fall and winter precipitation led to an explosion of wildflowers in the Southwest, fed by above-average precipitation over much of fall and winter, and boosted by recent above-average temperatures. Pollen levels are also up, and most allergy sufferers will feel the effects from a wide range of pollen sources. A few severe dust events have already resulted in interstate closures, and if warm and dry conditions persist, this could lead to increased dust and particulate matter. The wet fall and winter combined with rapid warming this spring also favors increased production of fine fuels that can carry fire. Current outlooks identify increased fire risk for portions of New Mexico, but fire managers will pay close attention to seasonal weather conditions throughout the region to watch for events or conditions that amplify fire risk.

El Niño Southern Oscillation: With La Niña in the rear-view mirror, forecasts are currently looking towards a possible El Niño event later in 2017. Most forecasts and models call for ENSO-neutral conditions to last through at least spring 2017 (and likely into summer) with a possible return of El Niño conditions in fall 2017 (for more details see pp. 3-5).

Precipitation & Temperature Forecast: The March 16 NOAA Climate Prediction Center's outlook for April calls for equal chances of above- or below-average precipitation, and increased chances of above-average temperatures across the region. Likewise, the three-month outlook for April through June calls for equal chances of above- or below-average precipitation (Fig. 6, top) and increased chances of above-average temperatures (Fig. 6, bottom).

Tweet Mar SW Climate Outlook CLICK TO TWEET

MAR2017 @CLIMAS_UA SW Climate Outlook & Summary, ENSO Tracker, Reservoir Volumes -- http://bit.ly/2mNCVSf #SWclimate #AZWX #NMWX #SWCO

March Southwest Climate Outlook

Online Resources

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

Figure 2
High Plains Regional Climate Center
http://www.hprcc.unl.edu/

Figures 3-4
Western Regional Climate Center
http://www.wrcc.dri.edu/

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

Figure 6
NOAA - 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

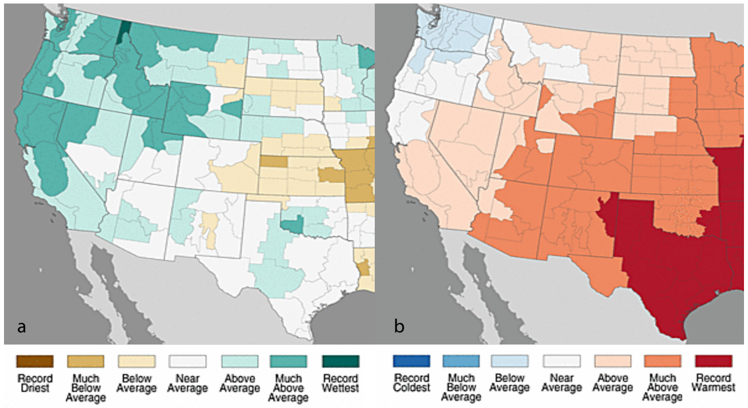


Figure 1: Feb 2017 Precipitation (a) & Temperature Ranks (b)

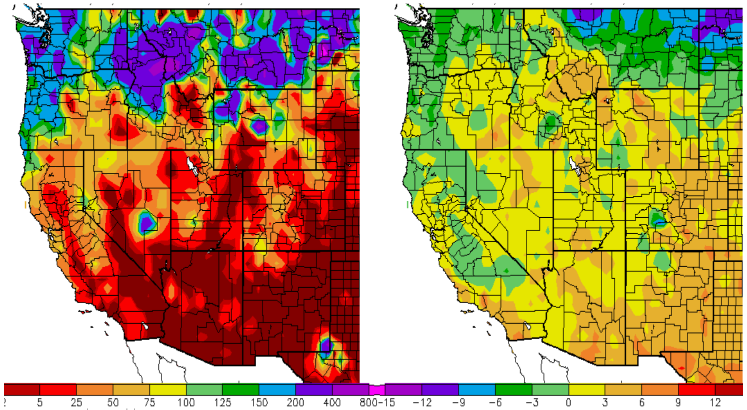


Figure 2: Mar 2017 Pct. of Ave. Precip. (a) & Temp. Departure from Ave. (b)

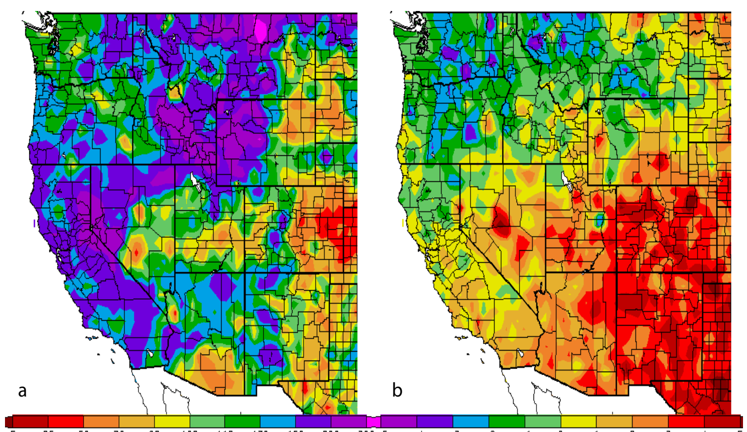


Figure 3: Water Year Pct. of Ave. Precip. (a) & Temp. Departure from Ave. (b)

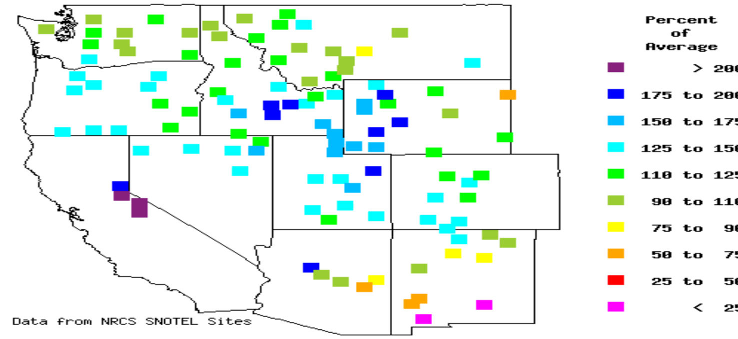


Figure 4: Basin Percent of Average Snow Water Equivalent (Mar 13, 2017)

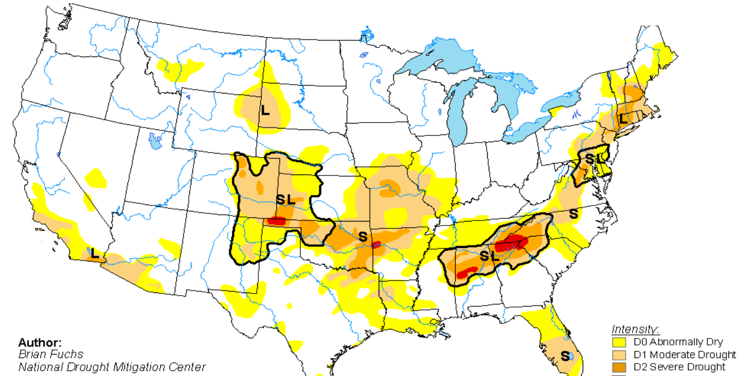


Figure 5: US Drought Monitor - Mar 14, 2017

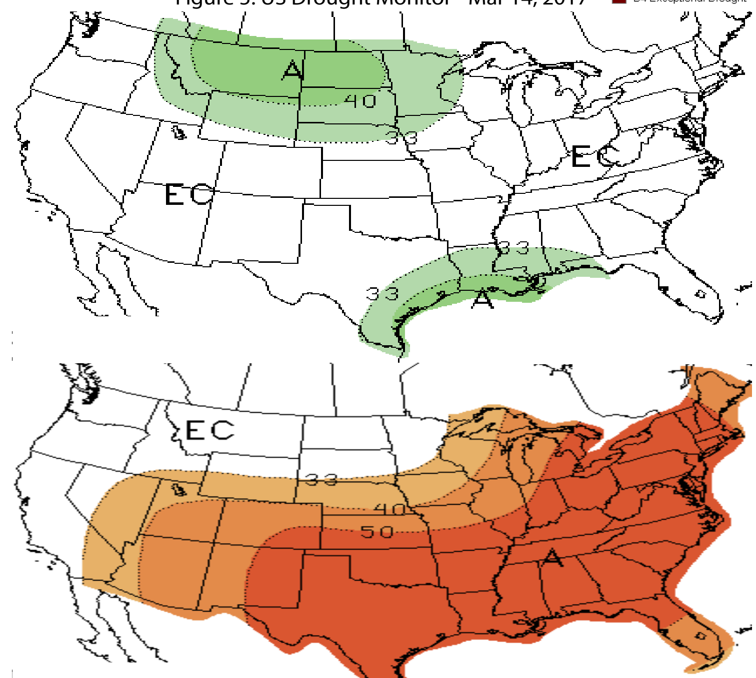


Figure 6: Three-Month Outlook - Precipitation (top) & Temperature (bottom) - Mar 16, 2017

Online Resources

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

Figure 2
NOAA - Climate Prediction Center
http://www.cpc.ncep.noaa.gov/

Figure 3
International Research Institute for Climate and Society
http://iri.columbia.edu

Figure 4
NOAA - Climate.gov
http://www.climate.gov/

NOAA - Climate.gov
The Spring Predictability Barrier: we'd rather be on Spring Break
http://bit.ly/1Xipsx7

El Niño / La Niña

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

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

ENSO Tracker

Oceanic and atmospheric indicators of the El Niño-Southern Oscillation (ENSO) are currently neutral (Figs. 1-2), and most forecast agencies predict they will remain so through spring 2017. These agencies also forecast that El Niño conditions could return in mid-to-late 2017, but given the uncertainty of ENSO forecasts associated with the "spring predictability barrier," (see link in sidebar) we can get only a general sense now of the range of outcomes likely later this year (i.e. La Niña is basically off the table). More detailed information about the timing or intensity of a possible El Niño will start to become available in late spring or early summer.

A closer look at the forecasts and seasonal outlooks provides insight into the range of predictions for the rest of winter and the ENSO signal for the rest of 2017. On March 9, the NOAA Climate Prediction Center (CPC) observed that oceanic and atmospheric conditions were consistent with ENSO-neutral conditions. They forecast a 75-percent chance of ENSO-neutral conditions through spring 2017 (March-May 2017), and a 50- to 55-percent chance of El Niño conditions in the second half of 2017 (July-Dec). On March 10, the Japanese Meteorological Agency (JMA) identified a continuation of ENSO-neutral conditions (last month they determined that observed conditions did not meet the JMA definition for a La Niña event). They forecast a 60-percent probability of ENSO-neutral conditions lasting through summer 2017, and a 40-percent chance of El Niño conditions over summer. On March 14, the Australian Bureau of Meteorology moved their ENSO outlook to El Niño Watch, with a 50-percent chance of an El Niño event. They identified warming oceanic conditions as indicating an increased chance of El Niño conditions in 2017. On March 16, the International Research Institute for Climate and Society (IRI) and CPC forecast a 70-percent chance of El Niño by late summer (Fig. 3), but forcasters also highlighted uncertainty regarding model performance given the spring predictability barrier.

The North American Multi-Model Ensemble (NMME) characterizes the current model spread and highlights the variability looking forward through the remainder of 2017. The NMME mean is forecast to remain ENSO-neutral through spring, but reaches the threshold of weak El Niño by early summer (Fig. 4).

(continued on next page)

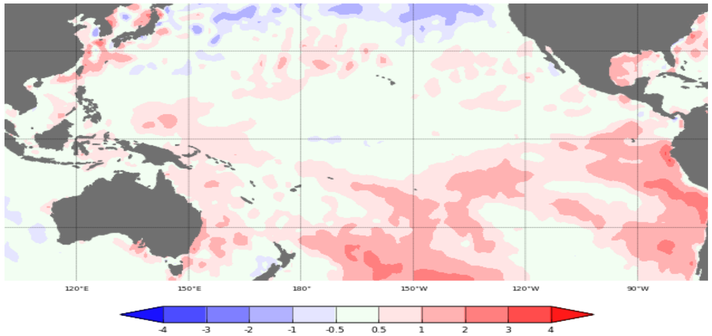


Figure 1: February 2017 Sea Surface Temperature (SST) Anomalies

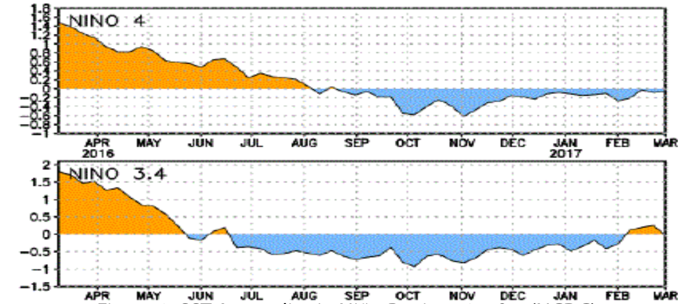


Figure 2: SST Anomalies in Niño Regions 3.4 & 4 (NCDC)

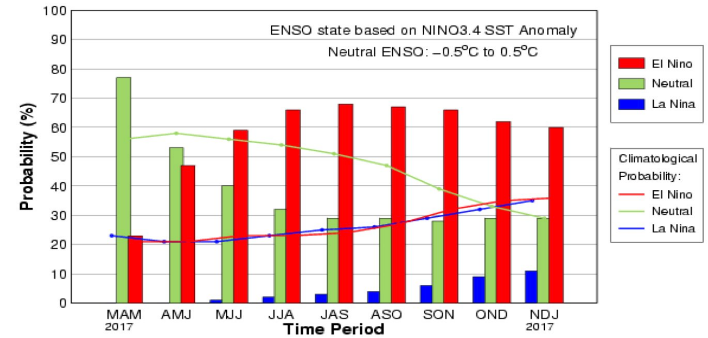


Figure 3: Mid-Mar IRI/CPC Model-Based Probabilistic ENSO Forecast

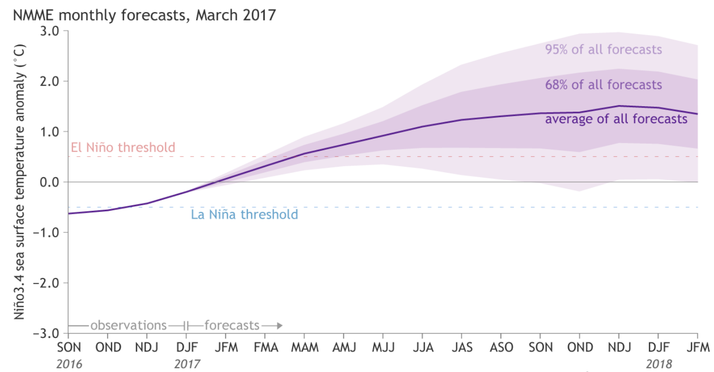


Figure 4: North American Multi-Model Ensemble Forecast for Niño 3.4

Online Resources

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

Figure 6
National Center for Environmental Information
http://www.ncdc.noaa.gov

Figures 7-8
Western Regional Climate Center
http://www.wrcc.dri.edu/

NOAA - Climate Prediction Center El Niño Criteria and Oceanic Niño Index Values
http://bit.ly/RjTP9B

El Niño / La Niña

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

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

ENSO Tracker - La Niña Recap

This event began in fall 2016, ended in early February 2017, and throughout the period oceanic and atmospheric indicators generally hovered near the boundary between weak La Niña and ENSO-neutral conditions. According to CPC criteria (see link in sidebar), this was a weak La Niña event (but just barely); other agencies use slightly different criteria (see last month for details), highlighting the difficulty in categorizing these borderline events. This weak strength also affects how precipitation and temperature patterns are interpreted. In the Southwest, a La Niña event is more likely than not to bring warmer- and drier-than-average conditions over the cool season, but a weak La Niña event might not even stand out from the normal seasonal variation of typically dry southwestern winters (Fig. 5).

So how did this La Niña event stack up compared to expectations? If last year's El Niño was an underperformer in terms of producing above-average precipitation, then this year's La Niña was a welcome deviation from precipitation expectations. Winter (DJF) precipitation was above average to much-above average across most of the West (Fig. 6a)—not the typical pattern associated with La Niña, but perhaps a reminder of just how "borderline" this La Niña event really was. Winter (DJF) temperatures generally matched the expected pattern of warmer than average in a La Niña year (Fig. 6b), although separating out the ENSO influence from general trends and record-warm global temperatures is difficult. The cool season (Oct-May) is not yet over, but the water year temperatures and precipitation values to date (Figs 7-8) generally mirrored the winter (DJF) pattern, save for a pocket of below-average precipitation along the Arizona borderlands region.

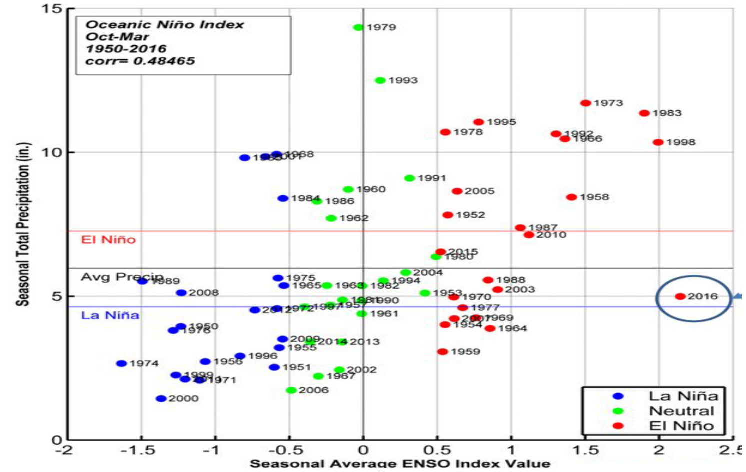


Figure 5: Arizona Climate Division 7 - ENSO vs. Precipitation

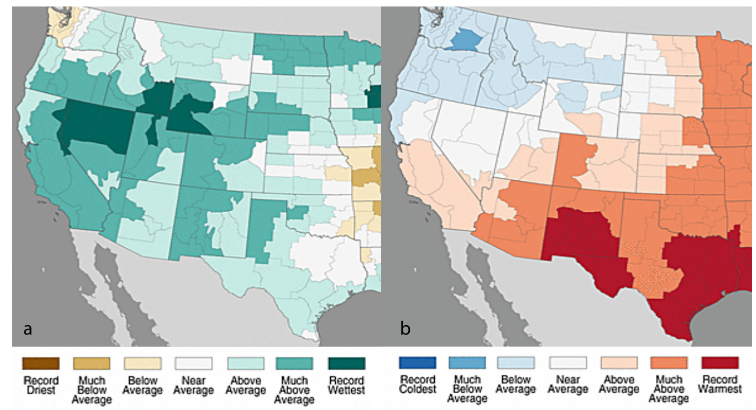


Figure 6: Winter (Dec-Feb) Precipitation (a) & Temperature Ranks (b)

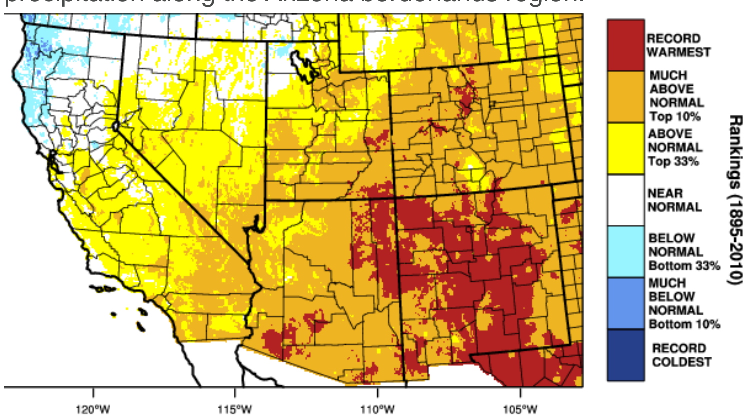


Figure 7: Water Year to Date (Oct-Feb) Mean Temperature Percentile

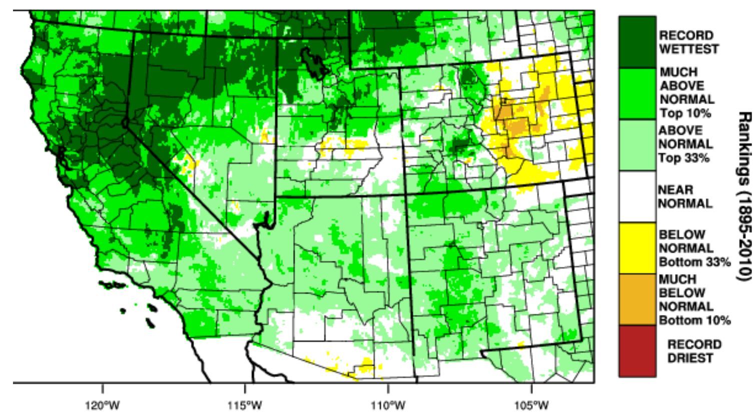


Figure 8: Water Year to Date (Oct-Feb) Precipitation Percentile

Online Resources

Figure 9a (this page)
Figures 9b-e (next page)
UA Climate Science Applications Program
http://cals.arizona.edu/climate

Figure 10
Natural Resources Conservation Service
http://www.wcc.nrcs.usda.gov/

La Niña Recap - continued

Looking to specific weather stations across the region, we see a similar pattern: most of the stations are recording above-average cool-season precipitation totals to date (Figs. 9a-b, 9d), aside from those in southern Arizona (Fig. 9c, 9e). Seasonal totals are not the entire story, and looking at the number of days with rain and dry spells (lower right corner of graphics) is another set of metrics that helps characterize the season. Many of the weather station plots reveal numerous lower-intensity precipitation events and a relatively greater number of days with rain, with correspondingly fewer and shorter dry spells (Figs. 9a-d) while fewer stations saw a smaller number of high-intensity events make up most of their seasonal precipitation total (Fig. 9e). Steady and soaking rains and higher-elevation snowfall are an important part of drought recovery, as more moisture is stored or banked in the system (as snowpack, soil moisture, etc.) and less is lost to runoff and evaporation.

In addition to cumulative seasonal totals and the number of days with rain over the season, precipitation must also be evaluated against the effects of elevated temperatures, which can reduce snowpack and water storage over winter and alter the timing of streamflow during spring and summer. Thus, there were concerns in the run-up to this La Niña event that its typical warmer temperatures and reduced precipitation would exacerbate existing drought conditions. Fortunately, La Niña's drier tendencies have not come to pass, and current snowpack, streamflow forecasts, and water resource management projections are generally optimistic (Fig. 10), offering hope that this pattern will last through spring and that elevated temperatures do not substantially affect snowpack or the timing of streamflow.

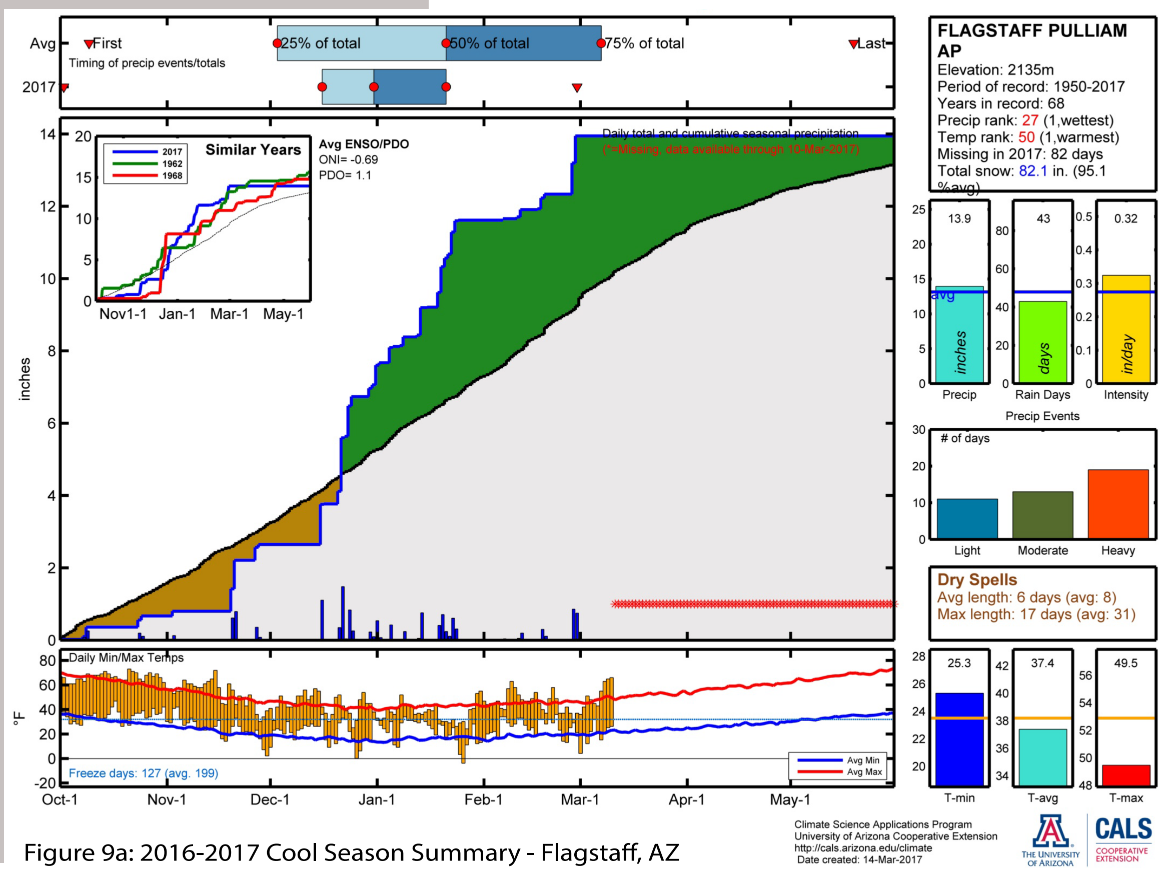


Figure 9a: 2016-2017 Cool Season Summary - Flagstaff, AZ

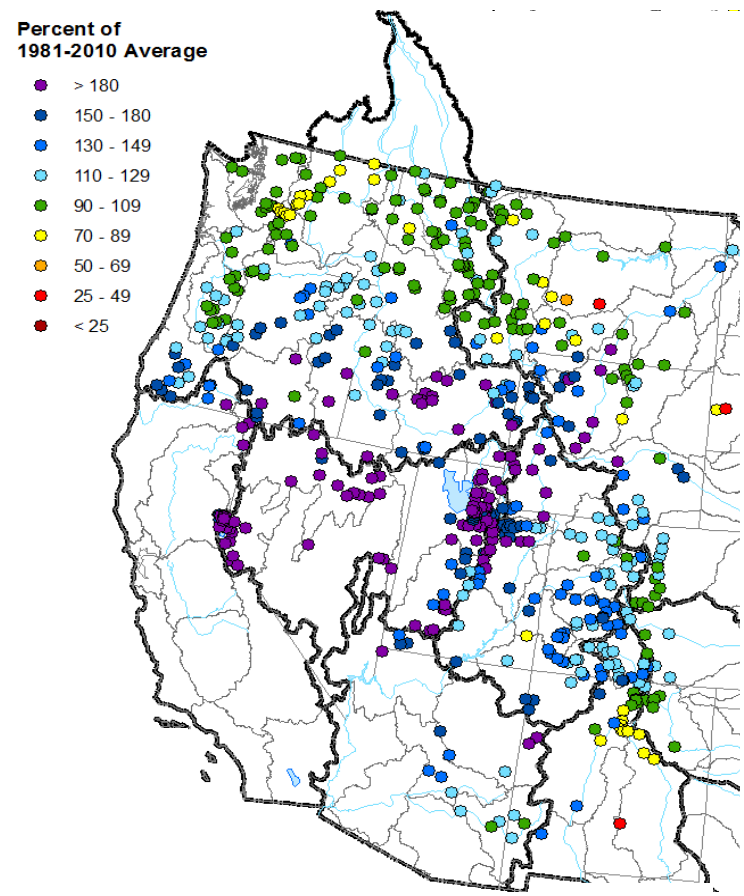


Figure 10: USDA NRCS Spring & Summer Streamflow Forecast - Mar 1, 2017

Online Resources

Figures 9b-e
UA Climate Science Applications Program
http://cals.arizona.edu/climate

Technical summary plots were created for stations across the region with high-quality long-term records.

High resolution versions available at: http://cals.arizona.edu/climate

Email Mike Crimmins to inquire about plots for additional stations or if you have any questions or suggestions on the plots.

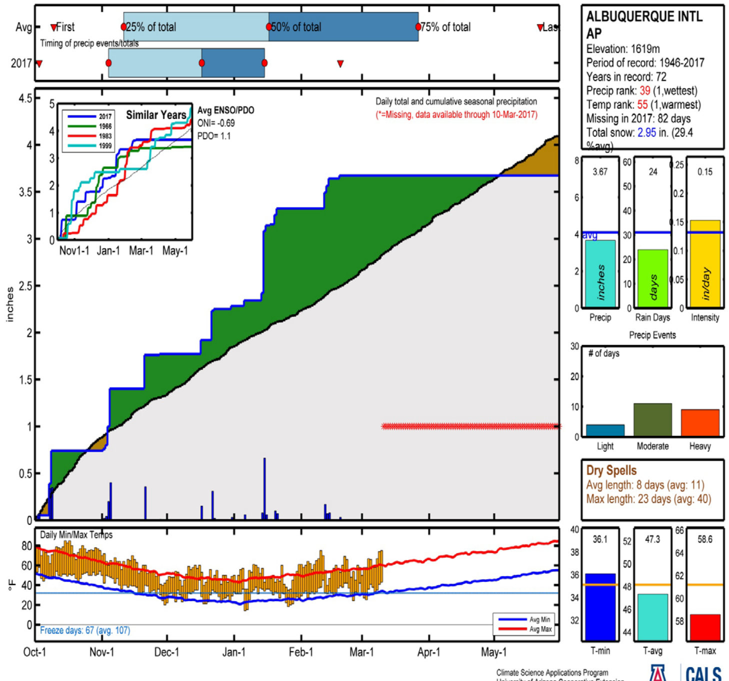


Figure 9b: 2016-2017 Cool Season Summary - Albuquerque, NM

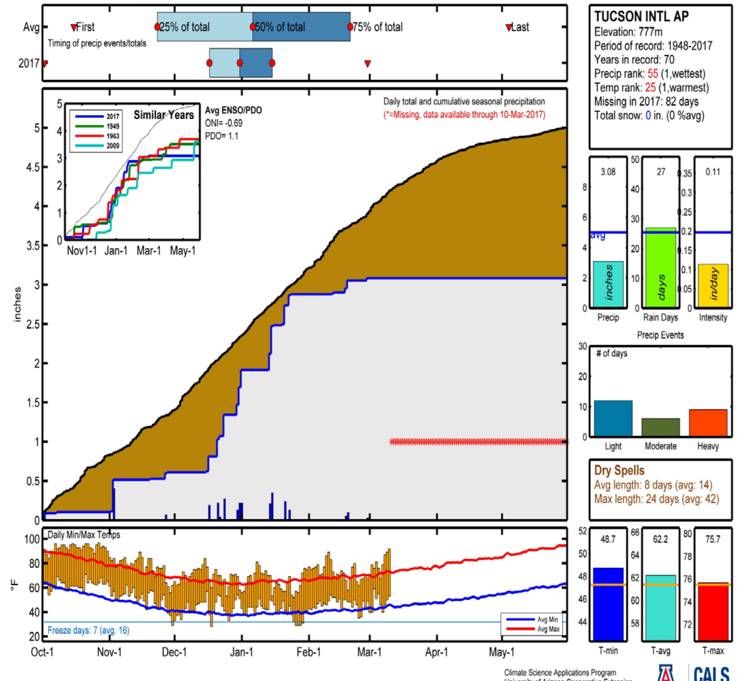


Figure 9c: 2016-2017 Cool Season Summary - Tucson, AZ

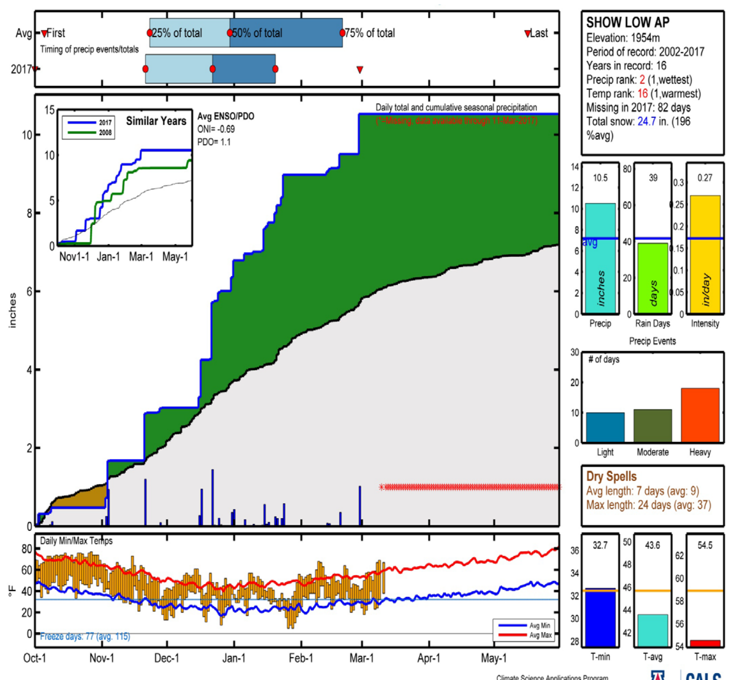


Figure 9d: 2016-2017 Cool Season Summary - Show Low, AZ

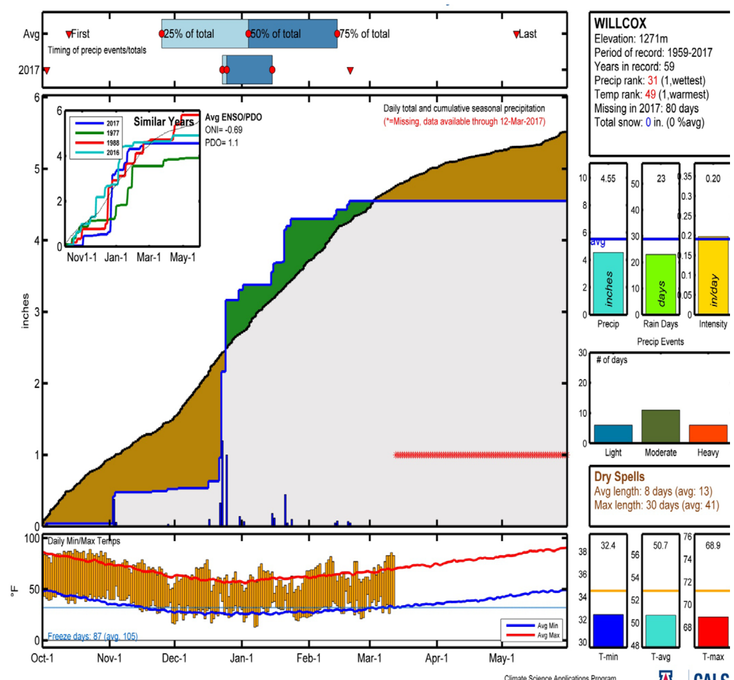


Figure 9e: 2016-2017 Cool Season Summary - Willcox, AZ

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

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).

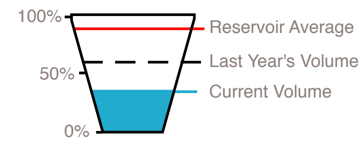
The table details more exactly the current capacity (listed as a percent of maximum storage). Current and maximum storage are given in thousands of acre-feet for each reservoir. One acre-foot is the volume of water sufficient to cover an acre of land to a depth of 1 foot (approximately 325,851 gallons). 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.

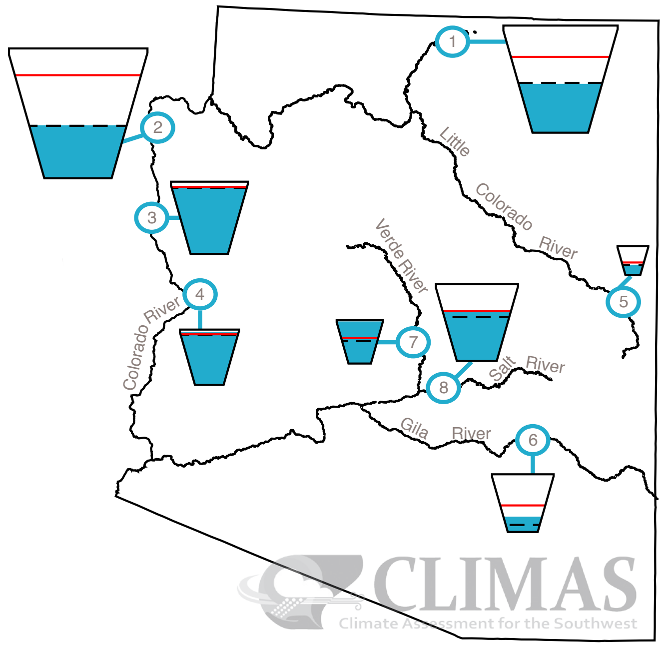
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS).

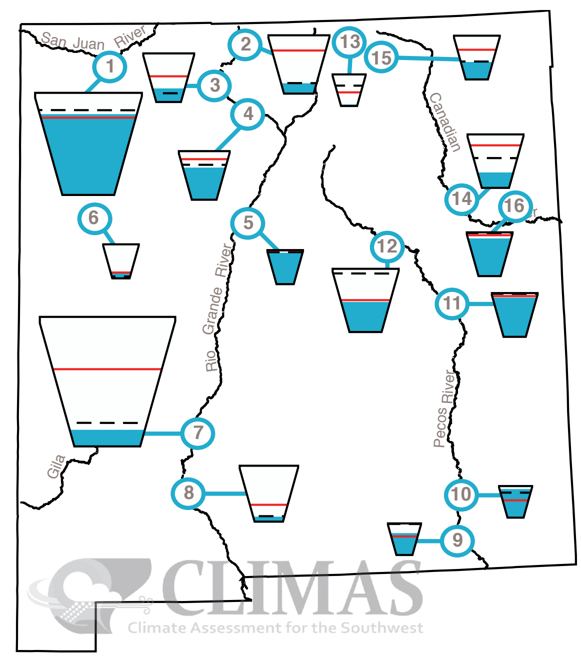
Reservoir Volumes

DATA THROUGH FEB 28, 2017

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	46%	11,212.4	24,322.0	-177.8
2. Lake Mead	41%	10,826.0	26,159.0	295.0
3. Lake Mohave	93%	1,688.0	1,810.0	-22.0
4. Lake Havasu	95%	587.8	619.0	18.4
5. Lyman	35%	10.5	30.0	3.5
6. San Carlos	26%	227.9	875.0	93.4
7. Verde River System	97%	280.1	287.4	54.8
8. Salt River System	65%	1,325.3	2,025.8	151.6

*KAF: thousands of acre-feet

* in KAF = thousands of acre-feet
**Reservoirs with updated "Max Storage"
***The last available reading for Costilla reservoir is Jan 5, 2017

Reservoir	Capacity	Current Storage*	Max Storage*	One-Month Change in Storage*
1. Navajo	79%	1,339.7	1,696.0	33.9
2. Heron	17%	67.1	400.0	1.7
3. El Vado	28%	53.9	190.3	3.5
4. Abiquiu	66%	123.7	186.8**	3.0
5. Cochiti	92%	46.0	50.0**	1.3
6. Bluewater	20%	7.8	38.5	4.9
7. Elephant Butte	13%	295.1	2,195.0	42.9
8. Caballo	9%	29.8	332.0	4.1
9. Lake Avalon	69%	3.1	4.5**	0.2
10. Brantley	90%	38.1	42.2**	1.2
11. Sumner	89%	31.9	102.0**	2.3
12. Santa Rosa	48%	51.3	105.9**	-0.2
13. Costilla	5%	5.3	16.0	***
14. Conchas	29%	73.6	254.2	1.5
15. Eagle Nest	40%	31.9	79.0	1.2
16. Ute Reservoir	86%	172	200	-1.0

Online Resources

Figure 1
Climate Program Office
http://cpo.noaa.gov/

RISA Program Homepage

http://cpo.noaa.gov/ClimateDivisions/ClimateandSocietalInteractions/RISAProgram.aspx

UA Institute of the Environment

http://www.environment.arizona.edu/

New Mexico Climate Center

http://weather.nmsu.edu/

CLIMAS Research & Activities

CLIMAS Research

www.climas.arizona.edu/research/

CLIMAS Outreach

www.climas.arizona.edu/outreach

Climate Services

www.climas.arizona.edu/climate-services

CLIMAS
Climate Assessment for the Southwest
A NOAA RISA TEAM

What is CLIMAS?

The Climate Assessment for the Southwest (CLIMAS) program was established in 1998 as part of the National Oceanic and Atmospheric Administration's Regional Integrated Sciences and Assessments program. CLIMAS —housed at the University of Arizona's (UA) Institute of the Environment—is a collaboration between UA and New Mexico State University.

The CLIMAS team is made up of experts from a variety of social, physical, and natural sciences who all work with partners across the Southwest to develop sustainable answers to regional climate challenges.

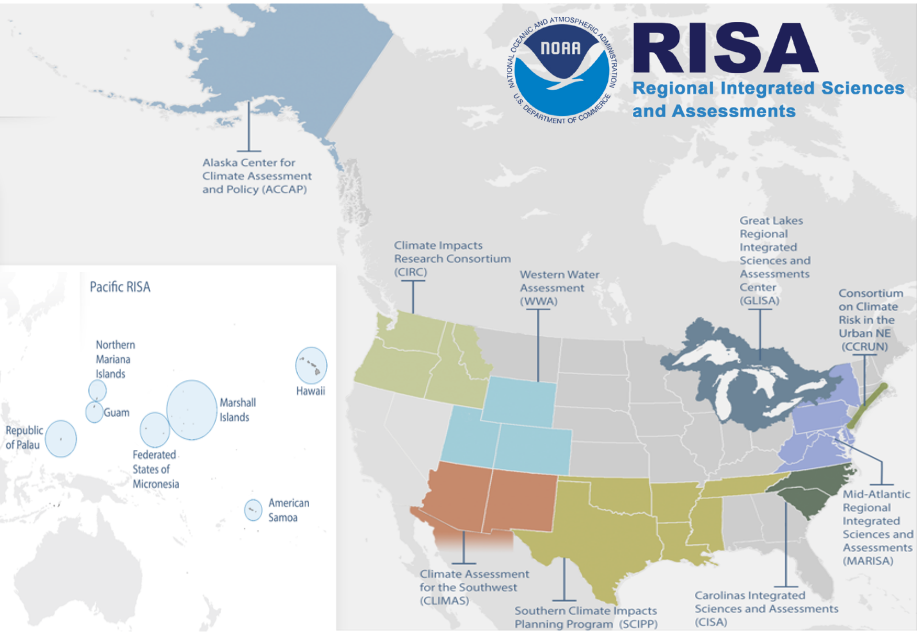


Figure 1: NOAA Regional Integrated Sciences and Assessments Regions

What does CLIMAS do?

The CLIMAS team and our partners work to improve the ability of the region's social and ecological systems to respond to and thrive in a variable and changing climate. The program promotes collaborative research involving scientists, decision makers, resource managers and users, educators, and others who need more and better information about climate and its impacts. Current CLIMAS work falls into six closely related areas: 1) decision-relevant questions about the physical climate of the region; 2) planning for regional water sustainability in the face of persistent drought and warming; 3) the effects of climate on human health; 4) economic trade-offs and opportunities that arise from the impacts of climate on water security in a warming and drying Southwest; 5) building adaptive capacity in socially vulnerable populations; 6) regional climate service options to support communities working to adapt to climate change.

Why is this work important?

Climate variability and the long-term warming trend affect social phenomena such as population growth, economic development, and vulnerable populations, as well as natural systems. This creates a complex environment for decision making in the semi-arid and arid southwestern United States. For example, natural resource managers focused on maintaining the health of ecosystems face serious climate-related challenges, including severe sustained drought, dramatic seasonal and interannual variations in precipitation, and steadily rising temperatures. Similarly, local, state, federal, and tribal governments strive to maintain vital economic growth and quality of life within the context of drought, population growth, vector-born disease, and variable water supplies. Uncertainties surrounding the interactions between climate and society are prompting decision-makers to seek out teams of natural and social scientists—like those that comprise CLIMAS—for collaborations to help reduce risk and enhance resilience in the face of climate variability and change.