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.

September Southwest Climate Outlook

Precipitation and Temperature: August precipitation ranged from much-below average to average across most of Arizona and New Mexico, except in eastern New Mexico where above-average to record-wettest conditions prevailed (Fig. 1a). August temperatures were average to much-above average in Arizona and most of New Mexico, with only the northeastern corner of New Mexico recording below-average temperatures (Fig. 1b). Temperatures during the June-July-August period have been mostly much-above average in Arizona and western New Mexico, and average to above average in eastern New Mexico (Fig. 2a). Year-to-date temperatures are persistently warmer than average, with much-above average and record-warmest conditions across nearly all of Arizona and New Mexico (Fig. 2b).

Monsoon Tracker: After a slow start in June and a record-wet July, precipitation in much of the Southwest has been mostly absent since early August. The high-pressure ridge that helped hold Hurricane Harvey in place over Houston kept moisture from circulating into the Southwest. The seasonal transition also played a role, as the mid-to-late monsoon period is typically much less conducive to widespread monsoon activity. This year, the late-season monsoon has been particularly dry, with very few storms and limited tropical storm activity that might otherwise help boost seasonal totals (Fig. 3).

Drought and Water Supply: Most of Arizona and New Mexico are currently designated as not experiencing widespread drought conditions on the most recent U.S. Drought Monitor (Fig. 4). An exception is the borderlands region of southern Arizona, which has designations of D0 (abnormally dry) and D1 (moderate drought) conditions, likely due to both short- and long-term precipitation deficits (Figs. 5a-b). The monsoon is challenging when it comes to assessing drought impacts, as precipitation events have high intensity and great spatial variability. Furthermore, runoff and evaporation also limit the monsoon's ability to mitigate drought conditions over large areas.

Health and Environmental Safety – Tropical Storms: Late September brings the period when regional atmospheric circulation patterns increase the likelihood that tropical storms could reach the Southwest. Looking at storms such as Norbert and Odile in 2014 and Octave in 1983 reveals the possible impacts these storms can have in terms of their effect on public perception and planning, along with their actual potential for extreme flood events. Coastal communities can see direct landfall impacts of tropical storms, but for Arizona and New Mexico, tropical storm activity most often acts as a moisture source for enhanced precipitation in late summer and early fall. These events can be relatively major for our region and warrant preparedness planning, although the possible impacts are of a different scale compared to major hurricane landfalls.

El Niño Southern Oscillation: Models and forecasts continue to indicate ENSO-neutral as one possible outcome, but recent forecasts have increased their probabilities of a La Niña event this fall. The CPC/IRI calls for a 55- to 60-percent chance of a La Niña developing based on numerous models shifting towards weak La Niña conditions (see ENSO Tracker on page 5 for more details). La Niña events typically bring warmer- and drier-than-average conditions to the Southwest during the cool season, but a weak strength tempers some of those effects. Regardless, these developments are worth keeping an eye on as we head into the cool season given lingering concerns about long-term drought and water storage in the Southwest over the past 15 years.

Precipitation and Temperature Forecast: The three-month outlook for October through December calls for equal chances of above- or below-average precipitation in Arizona and New Mexico (Fig. 6, top), and increased chances of above-normal temperatures for the entire southwestern United States (Fig. 6, bottom).

Tweet Sept SW Climate Outlook

CLICK TO TWEET

SEP2017 @CLIMAS_UA Climate Outlook, ENSO Tracker, Monsoon Tracker, Reservoir vol. http://bit.ly/2xl7lk9 #SWclimate #AZWX #NMWX #SWCO

September 2017 SW Climate Outlook

Online Resources

Figures 1-2
National Center for Environmental Information
www.ncdc.noaa.gov

Figure 3
CLIMAS: Climate Assessment for the Southwest
www.climas.arizona.edu

Figure 4
U.S. Drought Monitor
droughtmonitor.unl.edu/

Figures 5a-b
West Wide Drought Tracker
wrcc.dri.edu/wwdt/

Figure 6
NOAA - Climate Prediction Center
www.cpc.ncep.noaa.gov/

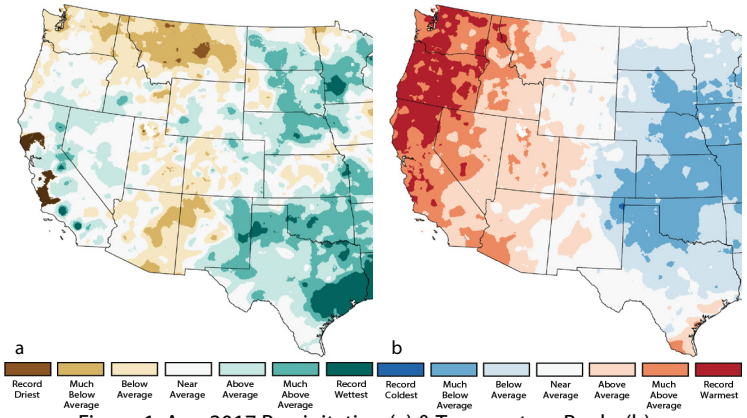


Figure 1: Aug 2017 Precipitation (a) & Temperature Ranks (b)

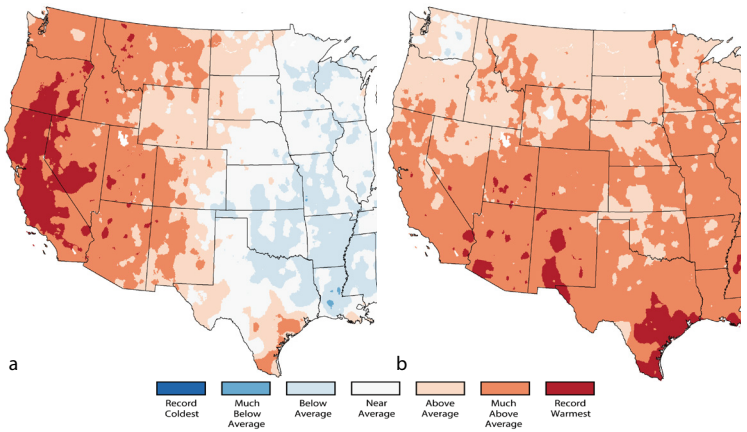


Figure 2: June-Aug 2017 (a) & Jan-Aug2017 (b) Temperature Ranks

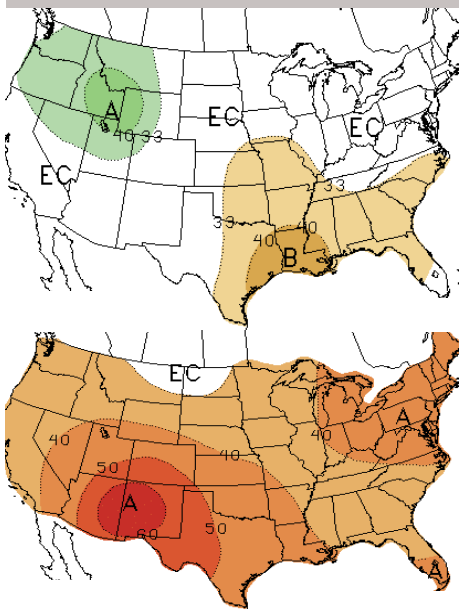


Figure 6: Three-Month Outlook - Precipitation (top) & Temperature (bottom) - Sept 21, 2017

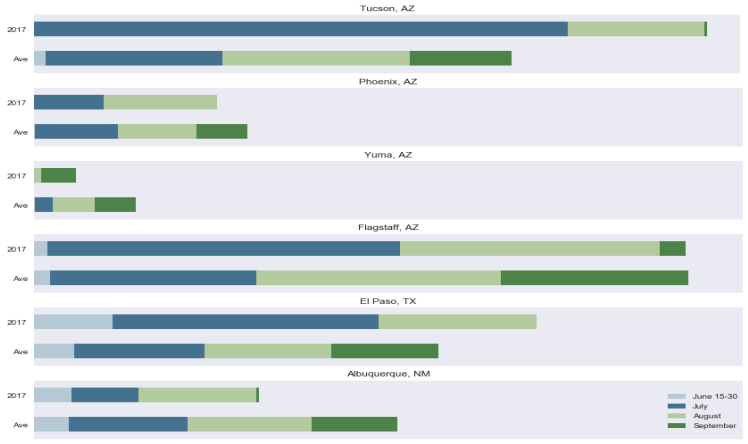


Figure 3: Monsoon Precip by Month - 2017 vs. Average (Source: NWS Tucson)

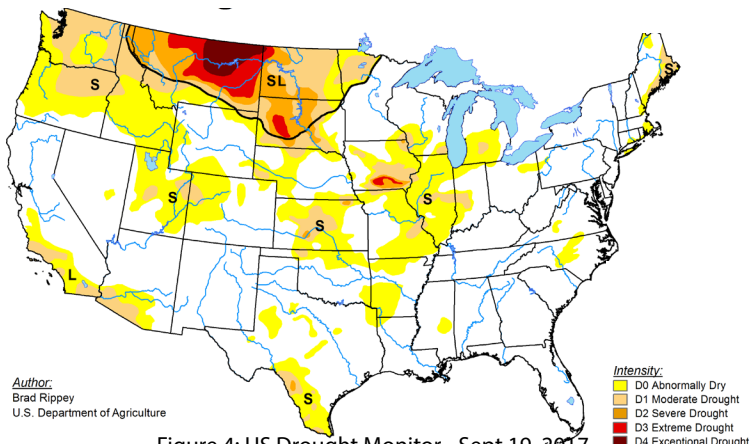


Figure 4: US Drought Monitor - Sept 19, 2017

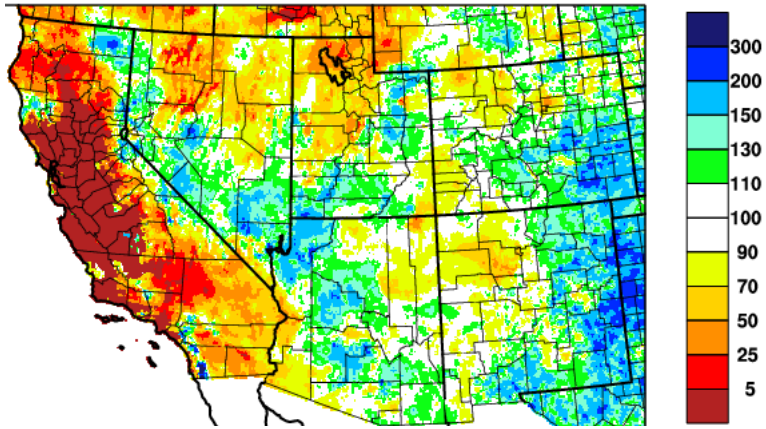


Figure 5a: July-August 2017 Precipitation Percent of 1981-2010 Normal

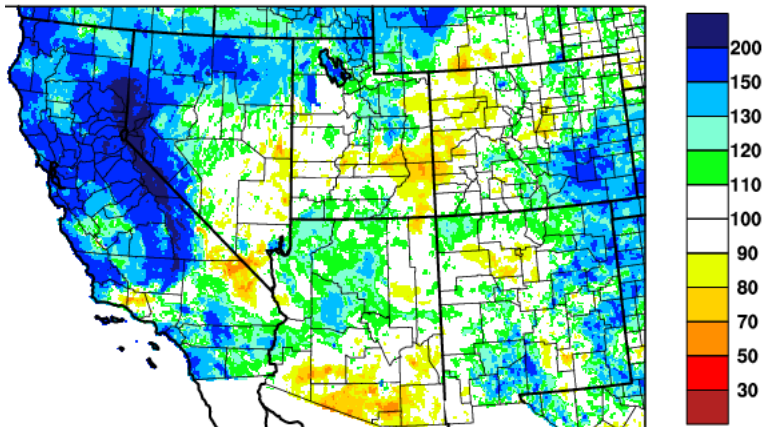


Figure 5b: October (2016) - Aug (2017) Precipitation Percent of 1981-2010 Normal

Online Resources

Figures 1-2
West Wide Drought Tracker
wrcc.dri.edu/wwdt/

Figure 3
Climate Science Applications Program
cals.arizona.edu/climate/

CLIMAS Monsoon Hub

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

www.climas.arizona.edu/sw-climate/monsoon

Southwestern Monsoon Tracker

The North American monsoon was quiet for much of the Southwest through early July, but mid-July through early August saw an impressive run of storms. July was particularly active in southeast Arizona, where numerous locations approached or set single-month records for precipitation. Since early August, however, Arizona has experienced a widespread shutdown of monsoon activity, while New Mexico has seen more regular precipitation. Seasonal totals (June 15 – Sept 13) for weather stations in regional metropolitan areas range from below to above average (Fig. 3 on p. 2), with the more impressive totals (Tucson, El Paso) resulting from near-record precipitation in July. The second half of August and September so far have been disappointingly below average, or at best near average for many locations. Looking at precipitation maps for specific months, July was mostly above normal (top 33 percent) and much-above normal (top 10 percent) across nearly all of Arizona and much of western and northern New Mexico (Fig. 1). August flipped that script, with most of Arizona and western New Mexico recording below-normal or much-below-normal precipitation, and with a large pocket of dry conditions centered over the Four Corners region even while eastern New Mexico was much-above normal to record wettest (Fig. 2). Looking at the cumulative seasonal precipitation totals moderates the large monthly variations (see percent of normal through Sept. 19; Fig. 3), and reveals a high degree of spatial heterogeneity of precipitation across the region. In other words, it was a normal monsoon.

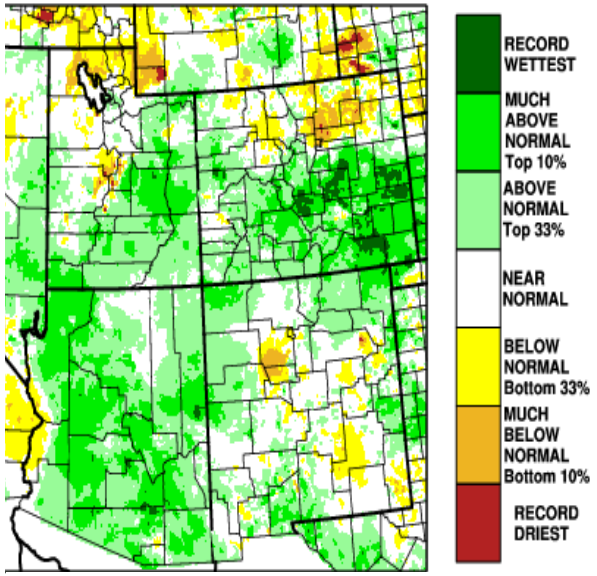


Figure 1: July 2017 Precipitation Percentile

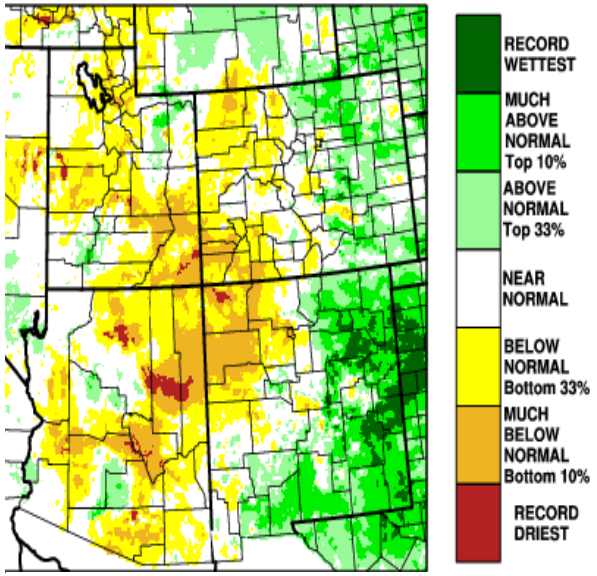
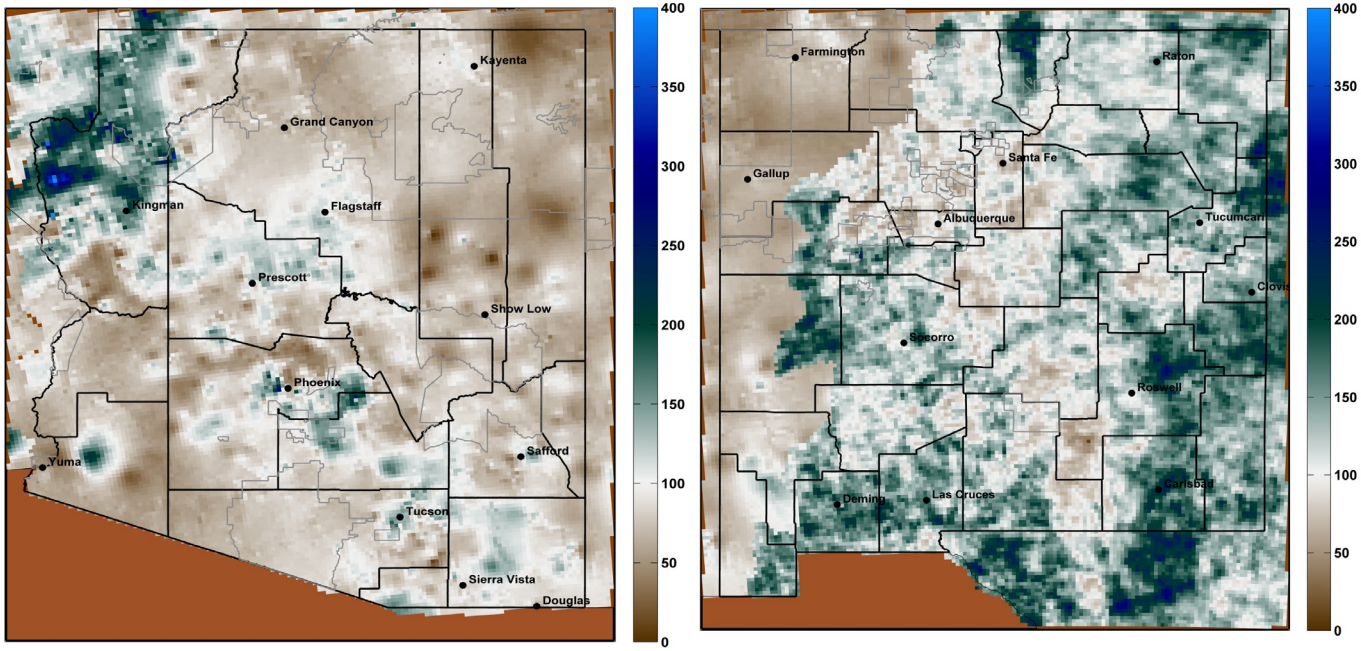


Figure 2: August 2017 Precipitation Percentile



Map produced using daily total precipitation estimates from the NOAA National Weather Service Advanced Hydrologic Prediction Service (AHPS). Data information available at http://water.weather.gov/precip/about.php. Date created: 20-Sep-2017 University of Arizona - http://cals.arizona.edu/climate/

Map produced using daily total precipitation estimates from the NOAA National Weather Service Advanced Hydrologic Prediction Service (AHPS). Data information available at http://water.weather.gov/precip/about.php. Date created: 20-Sep-2017 University of Arizona - http://cals.arizona.edu/climate/

Figure 3a-b: Percent of Average Precipitation - Jun 15 - Sept 19, 2017

Online Resources

Figures 4a-b
Climate Science Applications Program
cals.arizona.edu/climate/

Figure 5
CLIMAS: Climate Assessment for the Southwest
climas.arizona.edu

CLIMAS Monsoon Hub

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

www.climas.arizona.edu/sw-climate/monsoon

Southwestern Monsoon Tracker (cont.)

Another way to assess the dry conditions of the last 30 to 45 days is by looking at the number of days since a rain event greater than 0.05 inches (Figs. 4a-b). These maps highlight widespread areas of Arizona and New Mexico that have recorded 20 or more such "dry days" and much larger areas for which it has been 10-15 days since the last rain event. Variable precipitation is a fundamental characteristic of the monsoon, so these gaps are generally expected to occur. Since the bulk of monsoon precipitation falls during July and August, an extended dry run starting in mid-August will limit the overall seasonal total for the region. We are seeing this now, as seasonal totals are mostly falling close to climatology in spite of the higher expectations that were set over the wet period from mid-July to early August (Fig. 5).

There is still a chance of additional precipitation in the remaining days of the official monsoon (which ends on Sept. 30), but activity during this time of year is often attributable to an influx of moisture from eastern Pacific tropical storms that recurve back into the Southwest, especially later in the tropical storm season. Currently, there are no such events forecasted over the next few weeks, thus the current monsoon precipitation totals are likely to also be the final seasonal totals. September 30 only marks the official end of the monsoon, but not an end to potential moisture influx to the Southwest from tropical storms, as evidenced by numerous October events that have resulted from such activity.

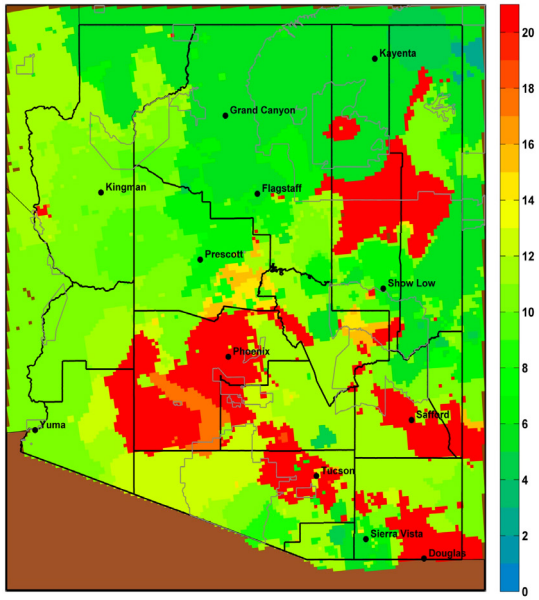


Figure 4a: Days Since Rain Event (>0.05") - Jun 15 - Sep 19

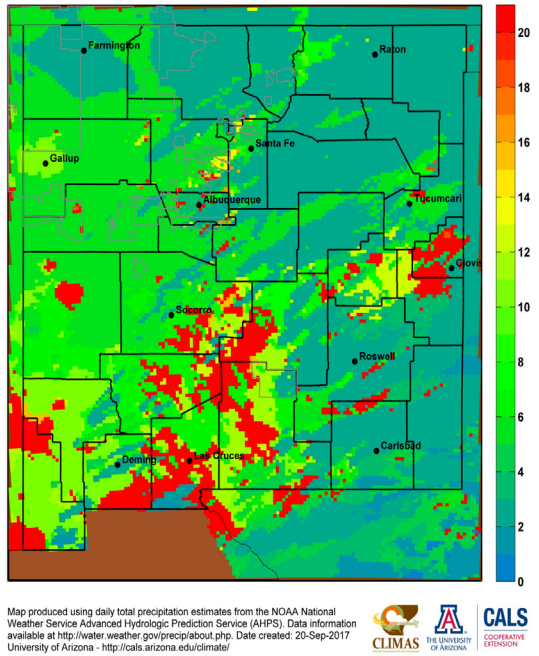


Figure 4b: Days Since Rain Event (>0.05") - Jun 15 - Sep 19

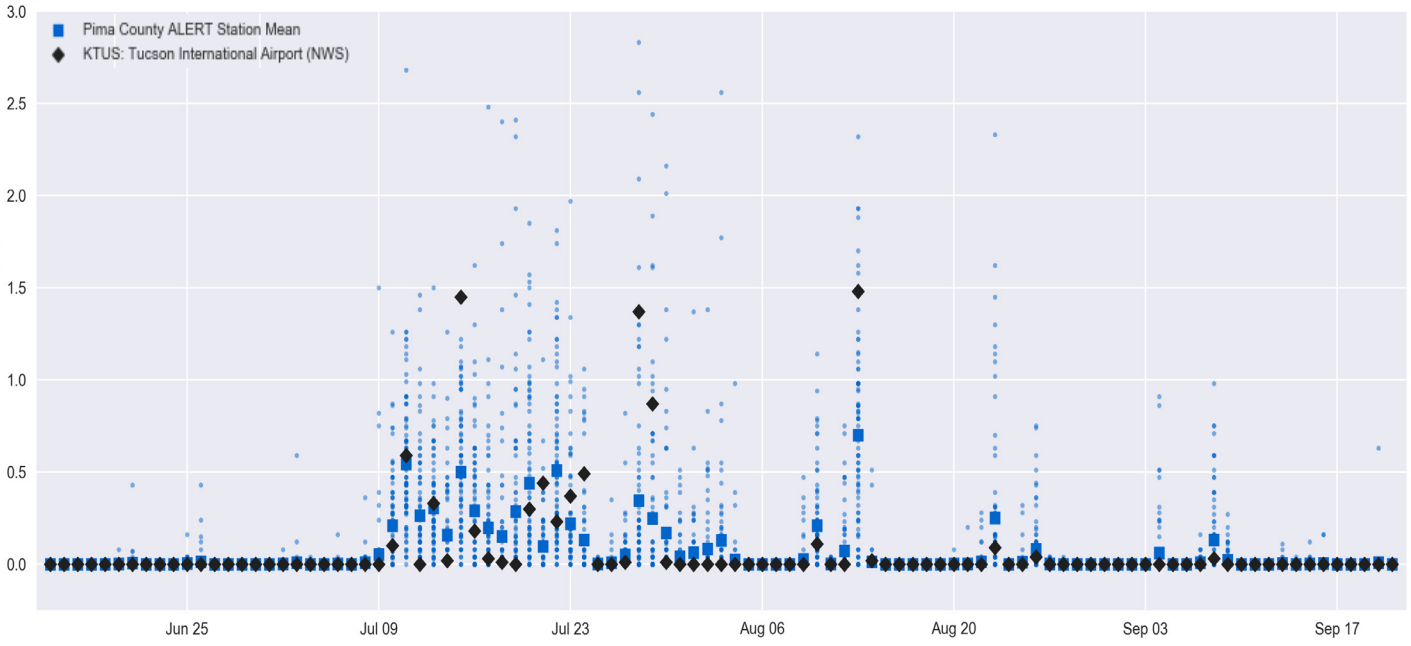


Figure 5: Daily Monsoon Precipitation - Pima County ALERT Network (Blue) & Tucson International Airport (Black)

Online Resources

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

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

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

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

International Research Institute for Climate and Society
iri.columbia.edu - #IRIforecast

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

El Niño-Southern Oscillation (ENSO) - Tracker

Oceanic and atmospheric indicators remain within the range of neutral but have shifted more towards La Niña conditions in the past month (Figs. 1-2). Seasonal outlooks and forecasts reflect these changes, and most now see La Niña conditions as the more likely outcome for fall 2017, with ENSO-neutral conditions mostly still favored for winter. On Sept. 11, the Japanese Meteorological Agency (JMA) forecast that ENSO-neutral conditions had a 60-percent chance of persisting through winter 2018, but that the chance of La Niña had increased to 40 percent. On Sept. 12, the Australian Bureau of Meteorology ENSO tracker remained at neutral/inactive; they noted that the tropical Pacific is on a cooling trajectory (supporting potential La Niña formation) but that other indicators remained within the range of ENSO-neutral. On Sept. 14, the NOAA Climate Prediction Center (CPC) observed that oceanic and atmospheric conditions were shifting towards La Niña, with a 55- to 60-percent chance of a La Niña event in winter 2017-2018. On Sept. 21, the International Research Institute for Climate and Society (IRI) and CPC identified cool oceanic conditions and that "La Niña odds edge out neutral" over winter 2017-2018. The North American Multi-Model Ensemble (NMME) is ENSO-neutral as of September 2017 (Fig. 4), with a majority of the models predicting ENSO neutral or weak La Niña this winter.

Summary: In a slight shift from the last few months' forecasts favoring ENSO-neutral conditions for this fall and winter, seasonal outlooks have turned more bullish on a weak La Niña event this fall. While many of the ENSO indicators remain within the range of neutral, oceanic indicators in particular have moved towards La Niña. What has caused the slight uptick in the likelihood of a 2017-2018 La Niña event that we noted in last month's forecasts to become more pronounced? One answer is related to the way that expert forecasters respond to model outputs. The CPC/IRI outlook on Sept. 14 stated that "a majority of the models in the IRI/CPC suite of Niño-3.4 predictions favor ENSO-neutral through the Northern Hemisphere 2017-18 winter," but they saw something in the NCEP Climate Forecast System (CFSv2) and North American Multi-Model Ensemble (NMME) that indicated a more rapid swing to La Niña conditions, and this influenced the overall assessment of an increasing chance of a weak La Niña this fall. It remains to be seen whether the winter will play out with ENSO-neutral or weak La Niña conditions. Given the warmer- and drier-than-average conditions associated with La Niña, this will be a closely watched phenomena going into the cool season of the Southwest, but neither scenario points toward particularly abundant winter precipitation.

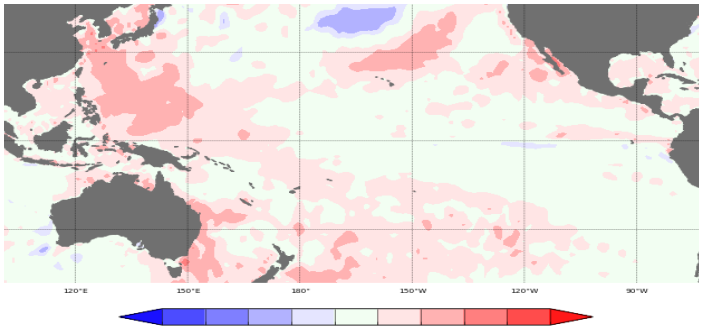


Figure 1: Aug 2017 Sea Surface Temperature (SST) Anomalies

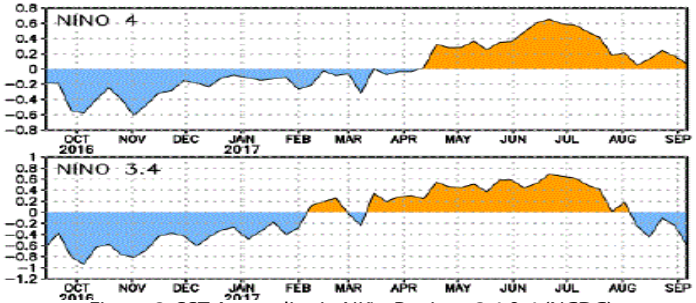


Figure 2: SST Anomalies in Niño Regions 3.4 & 4 (NCDC)

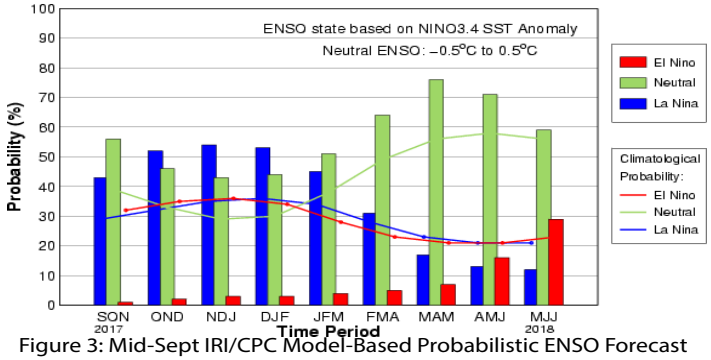


Figure 3: Mid-Sept IRI/CPC Model-Based Probabilistic ENSO Forecast

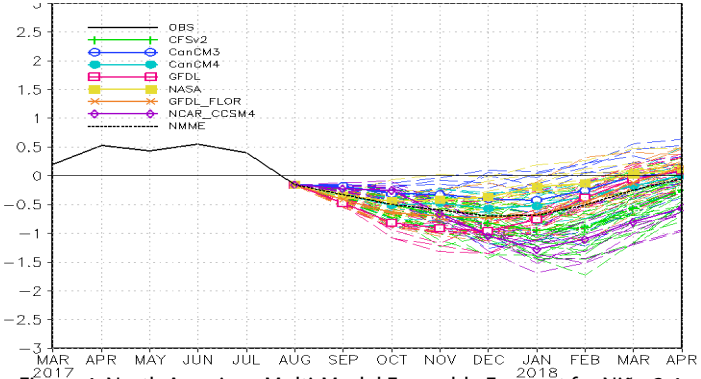


Figure 4: North American Multi-Model Ensemble Forecast for Niño 3.4

Online Resources

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

Arizona: usa.gov/19e2BdJ

New Mexico: 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).

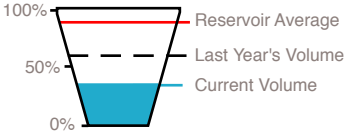
The table details more exactly the current capacity (listed as a percent of maximum storage). Current and maximum storage are given in thousands of acre-feet for each reservoir. One acre-foot is the volume of water sufficient to cover an acre of land to a depth of 1 foot (approximately 325,851 gallons).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

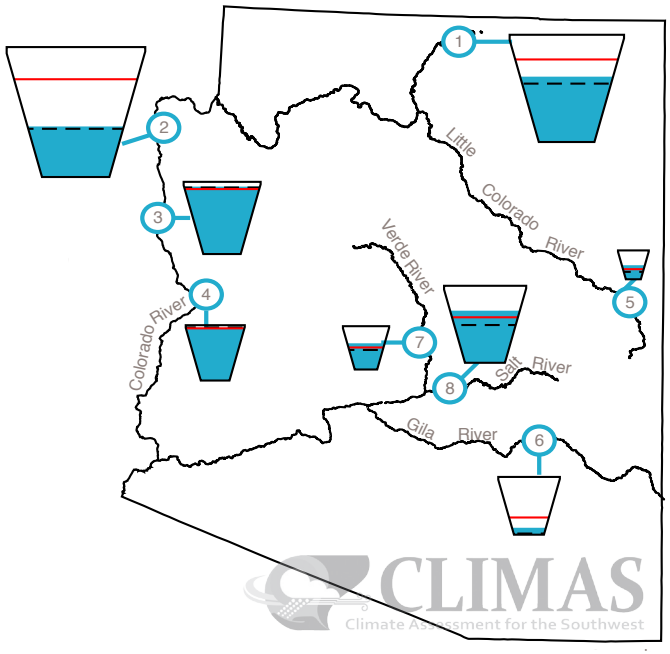
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS).

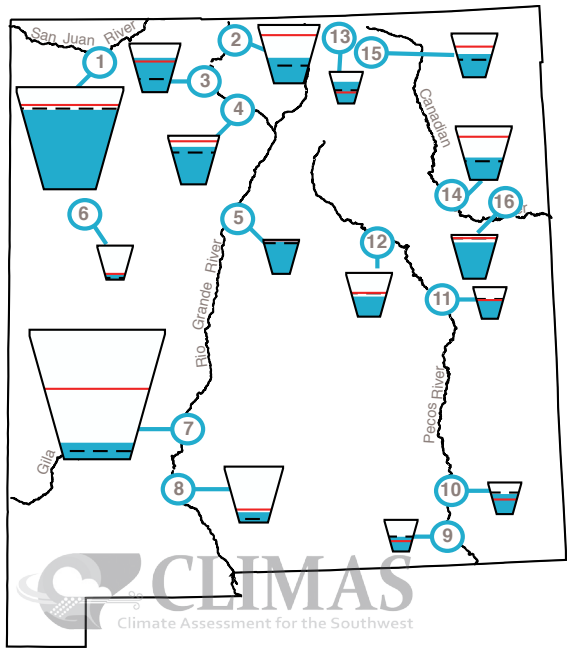
Reservoir Volumes

DATA THROUGH AUGUST 31, 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	61%	14,951.6	24,322.0	-433.1
2. Lake Mead	39%	10,131.0	26,159.0	200.0
3. Lake Mohave	93%	1,692.0	1,810.0	-52.3
4. Lake Havasu	95%	587.6	619.0	-5.9
5. Lyman	48%	14.5	30.0	-1.1
6. San Carlos	13%	111.3	875.0	-15.7
7. Verde River System	61%	175.8	287.4	2.0
8. Salt River System	68%	1,375.0	2,025.8	-31.1

*KAF: thousands of acre-feet

* in KAF = thousands of acre-feet
**Reservoirs with updated "Max Storage"

Reservoir	Capacity	Current Storage*	Max Storage*	One-Month Change in Storage*
1. Navajo	78%	1,323.5	1,696.0	-37.1
2. Heron	44%	174.1	400.0	-18.9
3. El Vado	71%	135.2	190.3	6.1
4. Abiquiu	76%	142.3	186.8**	-1.3
5. Cochiti	95%	47.7	50.0**	-1.5
6. Bluewater	19%	7.5	38.5	-0.7
7. Elephant Butte	13%	285.2	2,195.0	-81.7
8. Caballo	18%	61.0	332.0	-7.5
9. Lake Avalon	47%	2.1	4.5**	0.4
10. Brantley	63%	26.6	42.2**	3.1
11. Sumner	59%	21.3	102.0**	-1.1
12. Santa Rosa	47%	49.9	105.9**	15.4
13. Costilla	69%	11.0	16.0	-0.7
14. Conchas	41%	104.9	254.2	43.7
15. Eagle Nest	54%	42.6	79.0	0.4
16. Ute Reservoir	90%	182	200	16.0

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 Website

CLIMAS Blog

www.climas.arizona.edu/blog/

CLIMAS Graduate Fellows Program

www.climas.arizona.edu/education/fellowship-program

Photo Credits

Photo 1: Becky Brice

Photos 2-3: Danielle Johnson

CLIMAS Environment & Society Graduate Fellow Program

CLIMAS
Climate Assessment for the Southwest
A NOAA RISA TEAM

The Climate Assessment for the Southwest (CLIMAS) is now accepting applications for the Environment & Society Graduate Fellows Program (previously the Climate & Society Graduate Fellows Program) for funding during January-December 2018. The fellowship provides support for currently enrolled University of Arizona graduate students from any degree-granting program whose work is focused on the nexus of environmental research and decision making. Up to four fellowships in the amount of $4,750 each will be awarded in 2018. The Environment & Society Fellows Program is supported by the University of Arizona Office of Research, Discovery, & Innovation and CLIMAS.

Applications for the 2018 fellowship are due on Wednesday, October 18, 2017.

For more details: www.climas.arizona.edu/education/fellowship-program

Excerpts from Blog Posts by CLIMAS Graduate Fellows: *(visit the CLIMAS blog to read more)*

Climate and Water Resources of the Chuska Mountains - Becky Brice

In the fall of 2015, I began working with the Navajo Nation Department of Water Resources, Water Management Branch, to address water resource management questions they had about the Chuska Mountains. These mountains are the only native headwaters on the Navajo Nation, where water scarcity impacts Navajo tradition, culture and livelihood. Since our initial discussions, Water Management Branch staff and I have collaboratively developed guiding research questions about past changes in water and climate, and what they might mean for the future...

read more at www.climas.arizona.edu/blog/climate-and-water-resources-chuska-mountains

Climate Change in the Kaipara Catchment (NZ) - Danielle Johnson

I've tagged along on environmental monitoring patrols, ridden in logging trucks with forestry workers, played cow wrangler on a dairy farm, photographed coastal erosion from the back of a four-wheel-drive that smelled of turkeys, and attended a conference on the well-being of eels. I've had conversations on boats and beaches, in fields and farmhouses, by lakes, in rivers, cars and marae (meeting houses). This is what happens when an anthropologist is on the case.

read more at www.climas.arizona.edu/blog/beginning-understand-climate-change-kaipara-catchment

Online Resources

Figure 1
Climate Program Office
cpo.noaa.gov/

RISA Program Homepage

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

UA Institute of the Environment

www.environment.arizona.edu/

New Mexico Climate Center

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 work with partners across the Southwest to develop sustainable answers to regional climate challenges.

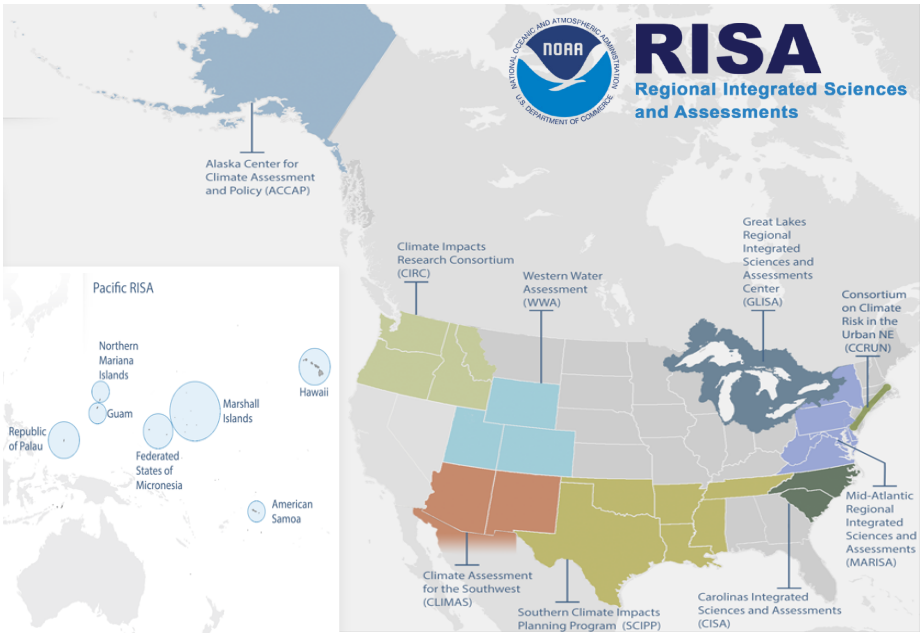


Figure 1: NOAA Regional Integrated Sciences and Assessments Regions

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; and 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.