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.

August Southwest Climate Outlook

Precipitation and Temperature: July precipitation totals were below average across most of Arizona and New Mexico in the past 30 days (Fig. 1a), due in part to an extended break in monsoon activity. July temperatures were above average across nearly the entire region (Fig. 1b), linked to global trends that saw record-warm temperatures in 2016 and to regional patterns of warmer and drier conditions that correspond to the aforementioned break in monsoon activity. August precipitation to date is average to above average for most of Arizona and portions of New Mexico (Fig. 2), partly linked to moisture associated with Tropical Storm Javier that resulted in heavy precipitation in parts of the Southwest. In August, temperatures have been mostly average to below average in Arizona and mostly above average in New Mexico (Fig. 3).

Monsoon: A strong start for the monsoon in late June was followed by an extended break in activity for much of July. The end of July saw another multi-day system that brought frequent storm activity to the region, particularly in southeastern Arizona, which has seen some of the heaviest monsoon activity this year. Seasonal totals to date for New Mexico generally have been below average, although August rainfall has helped make up some of the precipitation deficit.

Drought & Water Supply: Long-term drought persists across the Southwest (Fig. 4), reflecting multiple years of drought conditions and accumulating precipitation deficits. In the Aug. 16 U.S. Drought Monitor, most of Arizona was designated as experiencing moderate drought (D1), while most of New Mexico was designated as abnormally dry (D0). This pattern is unlikely to reverse in the short term, especially with a weak La Niña event likely occurring this fall into winter, which could bring warmer and drier conditions to the Southwest. Water year precipitation to date is below average in much of the Southwest, particularly in Southern California, most of southern Arizona, and western New Mexico (Fig 5).

La Niña: Sea surface temperature anomalies and atmospheric patterns all indicate ENSO-neutral conditions. Uncertainty remains as to whether an actual La Niña event will occur, but current model consensus points toward the formation of a weak La Niña event between now and October that is expected to last through winter 2017 (see La Niña Tracker).

Wildfire: Cooler and wetter-than-average conditions linked to the lingering effect of El Niño tamped down early-season fire activity in April and May. Fire activity picked up in June and July, but precipitation from cold front, monsoon, and tropical storm activity, as well as increased relative humidity across the region, helped limit the risk of severe wildfire. As of August, wildland fires had burned approximately 220,000 acres in Arizona and 274,000 acres in New Mexico. Favorable weather conditions permitted fire managers to let a number of fires burn for beneficial use to reduce future wildfire risk.

Precipitation & Temperature Forecasts: The July 21 NOAA-Climate Prediction Center's seasonal outlook for September calls for increased chances of above-average precipitation for most of Arizona and western New Mexico (Fig. 6, top) and increased chances of above-average temperatures across the western U.S. (Fig. 6, bottom). The three-month outlook for September through November calls for increased chances of above-average temperatures across the U.S.— and the Southwest in particular—while calling for equal chances of average, above-average, or below-average precipitation.

Tweet Aug SW Climate Outlook CLICK TO TWEET

AUG2016 @CLIMAS_UA SW Climate Outlook - Southwest Climate Summary, La Niña Tracker, Monsoon Recap - http://bit.ly/2bjur0D

August Southwest Climate Outlook

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

Figure 5
West Wide Drought Tracker
http://www.wrcc.dri.edu/wwdt

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

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www.climas.arizona.edu/media/podcasts

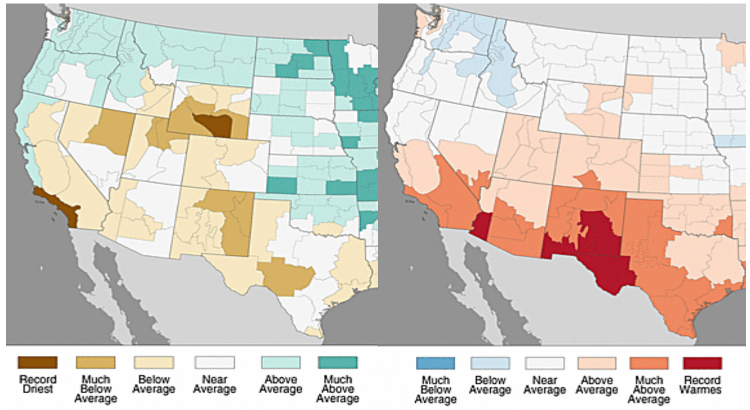

Figure 1: July 2016 Precipitation (a) & Temperature Ranks (b)

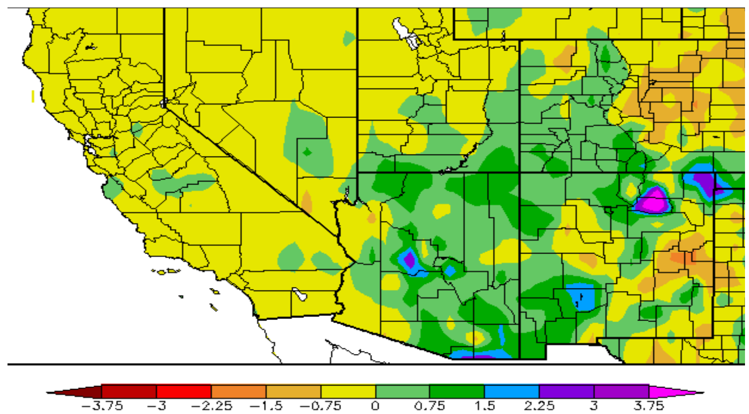

Figure 2: Departure from Normal Precipitation Aug 1 - Aug 17 2016

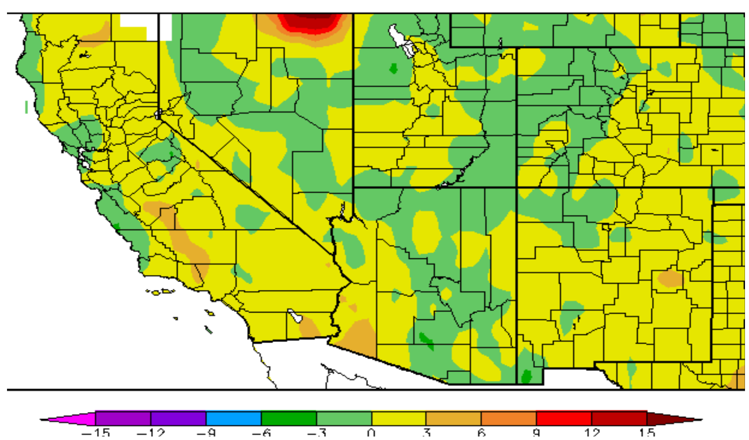

Figure 3: Departure from Normal Temperature Aug 1 - Aug 17 2016

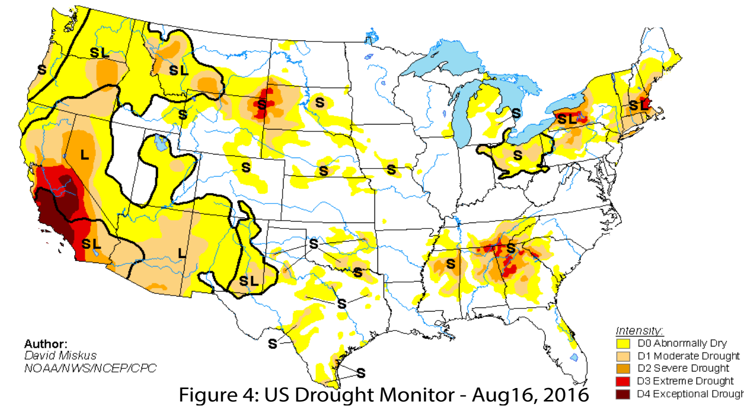

Figure 4: US Drought Monitor - Aug16, 2016

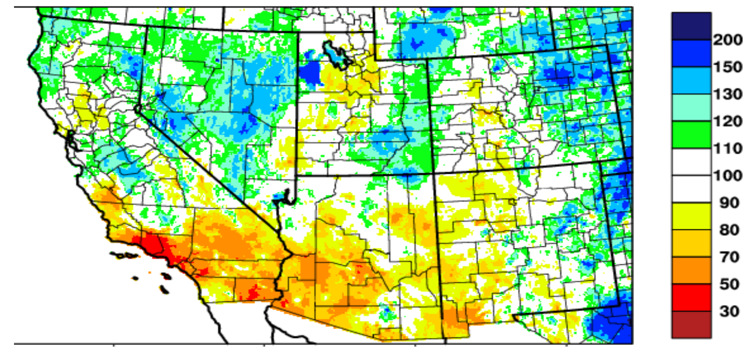

Figure 5: Percent of Normal Precipitation Oct 1 2015 - July 31 2016

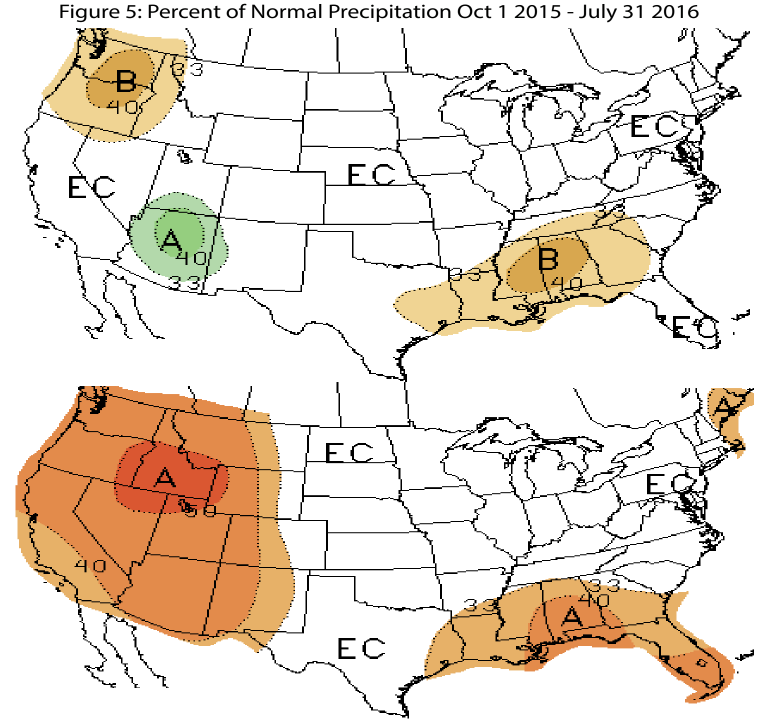

Figure 6: One-Month Precipitation & Temperature Outlook-Aug 18, 2016

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) remain in the range of neutral conditions (Figs. 1-2). Seasonal forecasts and models identify the most likely scenario being a weak La Niña event forming sometime in late summer or fall 2016 and lasting through winter 2017. Some uncertainty exists regarding the specific timing of this event, as the equatorial sea surface temperature (SST) anomalies have not yet dropped into La Niña range and there is a lack of coordination between ocean and atmosphere (and in particular the lack of enhanced trade winds).

A closer look at the various forecasts and seasonal outlooks provides insight into the range of expectations for this La Niña event. On August 10, the Japanese Meteorological Agency saw below-normal equatorial convective activity and enhanced trade winds as indicative of the start of La Niña-favorable conditions, even while the SST anomalies were slow to swing more negative (cool) after the sustained warm period associated with El Niño conditions. The agency forecast a 70 percent chance of a La Niña event developing, but not until fall 2016. On August 11, the NOAA Climate Prediction Center (CPC) highlighted ENSO-neutral conditions in both ocean and atmosphere and continued to focus on tension between statistical and dynamical models, the former predicting a later onset and weaker event than the latter. The CPC forecast remains at a 55–60 percent chance of a weak La Niña event starting sometime between August and October 2016. On August 16, the Australian Bureau of Meteorology maintained its La Niña watch, albeit with slightly reduced confidence compared to the previous month, hedging slightly by stating "if La Niña does develop it is likely be weak." The bureau maintained its forecast probability at a 50 percent chance of a La Niña event developing, noting that is approximately twice the normal chance of a La Niña forming. On August 18, the International Research Institute for Climate and Society (IRI) and CPC forecasts indicated the probability of a "borderline/weak" La Niña forming was just less than 60 percent (Fig. 3). The IRI forecasters noted that until the atmosphere cooperates (i.e., the enhanced trade winds show up), the ENSO-neutral holding pattern will remain. The North American multi-model ensemble characterizes the current model spread and highlights the variability looking forward to 2017, but the ensemble mean hovers close to weak La Niña status for fall and winter of the coming year (Fig. 4).

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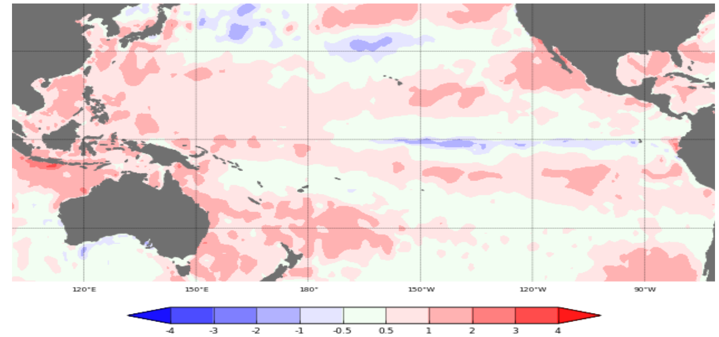


Figure 1: July 2016 Sea Surface Temperature (SST) Anomalies

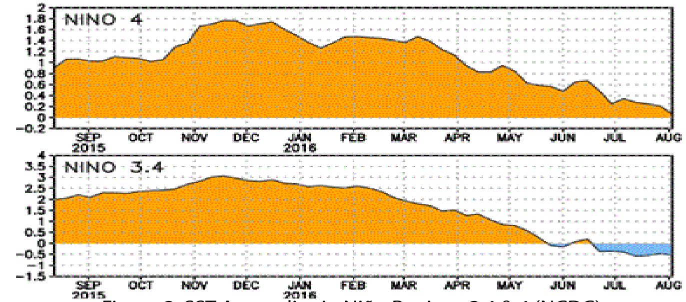


Figure 2: SST Anomalies in Niño Regions 3.4 & 4 (NCDC)

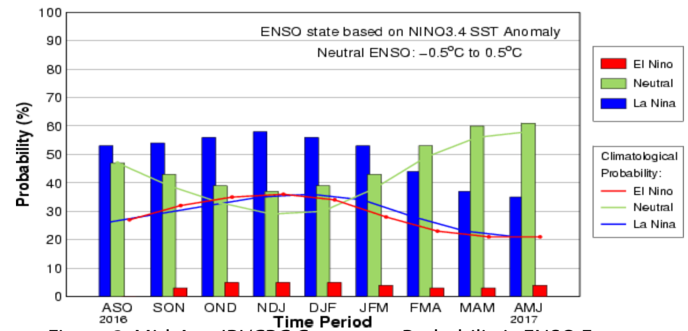


Figure 3: Mid-Aug IRI/CPC Consensus Probabilistic ENSO Forecast

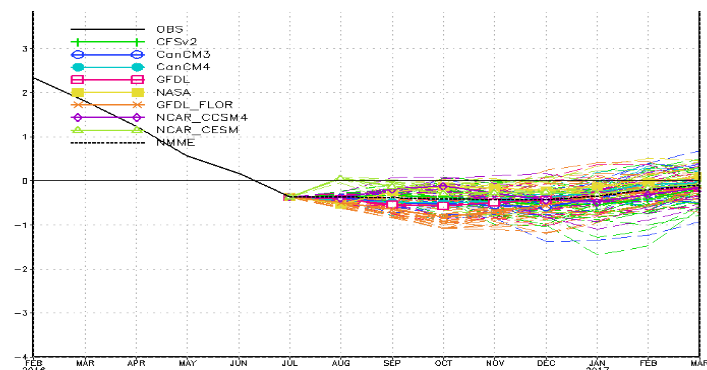


Figure 4: North American Multi-Model Ensemble Forecast for Niño 3.4

Online Resources

Figure 5
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

The Southwest is in a holding pattern regarding La Niña but will likely see the effects of a weak La Niña this winter. Forecasters are likely already integrating the influence of the drier-than-average signal associated with La Niña into long-term precipitation and temperature forecasts and seasonal outlooks (Fig. 5a-b), and researchers are preparing to track both the timing and intensity of this event in relation to precipitation, temperature, snowpack, and water supply over the coming year.

Given the dry climate of the Southwest, a weak La Niña event does not necessarily deviate far from the seasonal climatology of the region, but while ENSO-neutral winters have a wider range of precipitation values observed over winter, La Niña winters skew more dry. Even a weak La Niña event is likely to suppress winter precipitation totals in the Southwest, which is unwelcome news given the underperformance of last year's El Niño winter and the longer-term effects of multi-year drought.

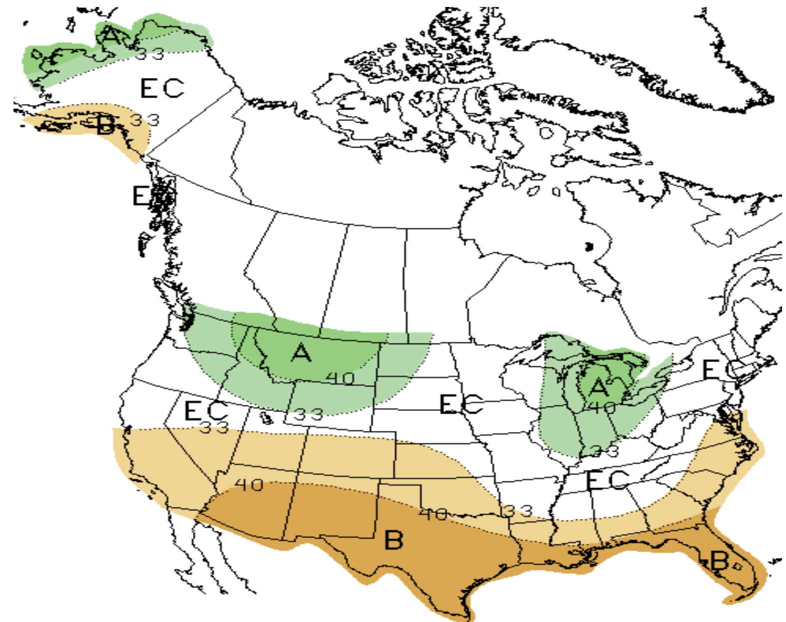


Figure 5a: Three-Month Precipitation Outlook Dec 2016 - Feb 2017

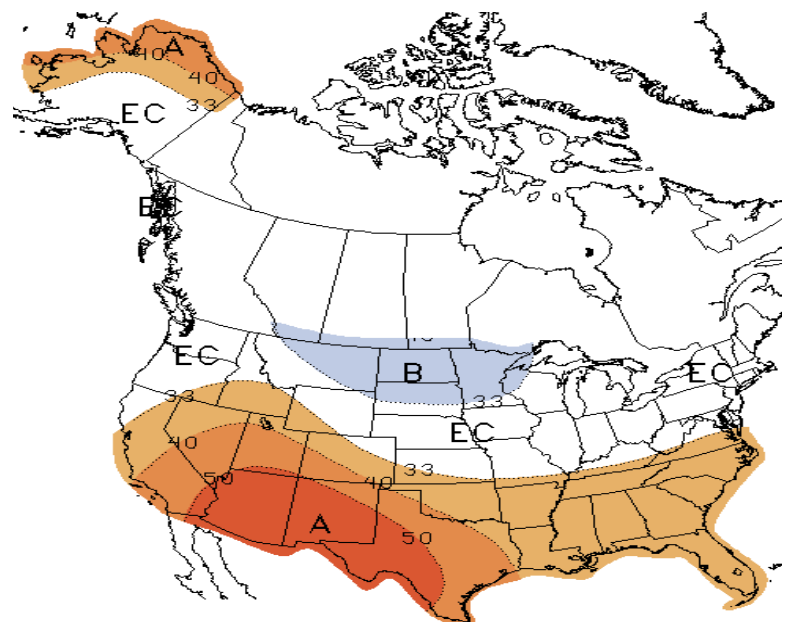


Figure 5b: Three-Month Temperature Outlook Dec 2016 - Feb 2017

Online Resources

Figure 1
Earth Systems Research Lab
http://www.esrl.noaa.gov

Figure 2
Climate Science Applications Program
http://cals.arizona.edu/climate

SW Monsoon

For More Information, visit:

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

Southwestern Monsoon

The southwestern monsoon officially starts June 15 and ends September 30. The National Weather Service began using these dates in 2008 to identify a discrete monsoon season as opposed to relying on varying assessments using dew point temperature and onset of precipitation events. Prior to 2008, the historical start date of the monsoon was based on observed conditions (primarily elevated dew point), which varied across the region in a way that reflected the generally westward migration of the monsoon onset (Fig. 1). Firm start and end dates may not perfectly align with regional variability (especially if monsoon conditions are not present at the calendar start to the monsoon), but standardized dates do provide a more consistent time frame to compare year over year and emphasize the spatial and temporal variability of the monsoon within and across years.

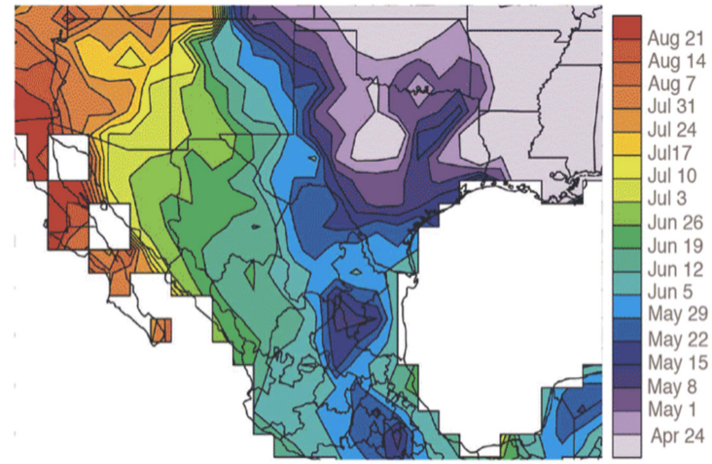


Figure 1: Historical Monsoon Onset Date

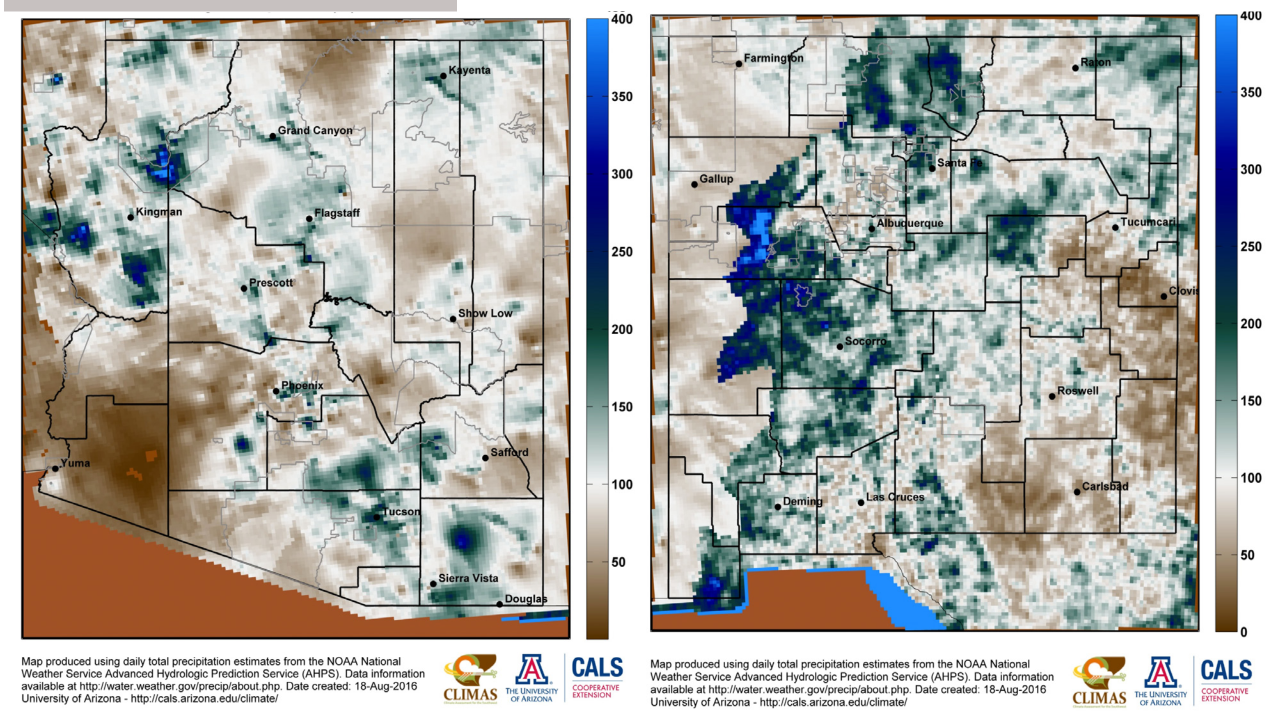


Figure 2a-b: Percent of Average Precipitation - Jun 15 - Aug 17

Monsoon Tracker (Jun 15 - Aug 17)

The Southwest saw the first strong burst of widespread monsoon activity near the end of June. Most of the first half of July was characterized by a distinct break in monsoon activity, as atmospheric circulation patterns and lack of available moisture limited opportunities for widespread storms to develop, especially at lower elevations. As July progressed, there were increasingly favorable conditions for storms to develop and spread, culminating in an extended period of widespread activity during late July and early August. Tropical Storm Javier helped jumpstart activity in mid-August, just as the previously mentioned extended run was winding down, and provided a brief extension to storm activity via a surge of moisture from the Gulf of California. The remainder of the monsoon window will be a waiting game to see if favorable moisture and atmospheric circulation patterns develop, as well as the potential influence of eastern Pacific tropical storm activity that could supplement storm activity and provide additional moisture to fuel storm activity.

(continued on next page)

Online Resources

Figures 3-5a
Climate Science Applications Program
http://cals.arizona.edu/climate

SW Monsoon

For More Information, visit:

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

Based on cumulative totals since the official start of the monsoon, most of Arizona recorded average to below-average precipitation, even while clusters of the state have recorded above-average precipitation as a percent of average (Fig. 2a) and in terms of outright totals (Fig. 3a). The percent of days with rain highlights the spatial variability of the monsoon and emphasizes the clustering of storms in the southeastern corner of the state (Fig. 4a). Precipitation plots from specific stations further highlight this variability, with Douglas, Flagstaff, and Tucson stations all on pace for average to above-average monsoon totals (Figs. 5a-c) but with the Tacna station in the southwest corner of Arizona yet to record a precipitation event (Fig 5d).

Cumulative totals since the start of the monsoon show that much of New Mexico recorded average to below-average precipitation, but with wider areas of above-average rainfall as well (Figs. 2b – 3b). The percent of days with rain also highlights the more regular coverage seen in New Mexico, with a wider swath of increased activity that covers most of the state (Fig. 4b). Station plots also demonstrate the lagging precipitation in select locations, with Albuquerque and El Paso, Texas, lagging behind seasonal totals (Figs. 5e-f). Stations closer to southern Arizona, such as the Animas 3ESE station, are recording above-average precipitation (Fig. 5g).

The southwestern monsoon is characterized by a high degree of spatial and temporal variability. Over the course of the season, storm events are interspersed with breaks of limited activity as migrating high pressure systems and available moisture dictates where in the Southwest rain might fall. This results in highly variable precipitation totals on a daily or weekly scale. Regional climatology gives some indication as to the expected cumulative total precipitation any location might expect but says less about how those precipitation totals will be achieved. Any given year of monsoon activity is difficult to categorize on a week-to-week basis, and simple score-carding using seasonal precipitation to date will be skewed by recent runs of heavy rain or extended breaks in the monsoon. Looking at daily precipitation event maps, there are very few days in which no rain fell anywhere in Arizona or New Mexico; there are numerous locations that saw little to no rain while nearby regions saw extensive precipitation. These totals should generally start to even out over the course of the season and vary around the long-term average, but outliers and extremes are always possible. As stated above, the remainder of the season is a waiting game to determine if and when a favorable atmospheric circulation brings additional storm activity into the region, or if tropical storm activity can help jumpstart these storms with additional surges of Gulf moisture.

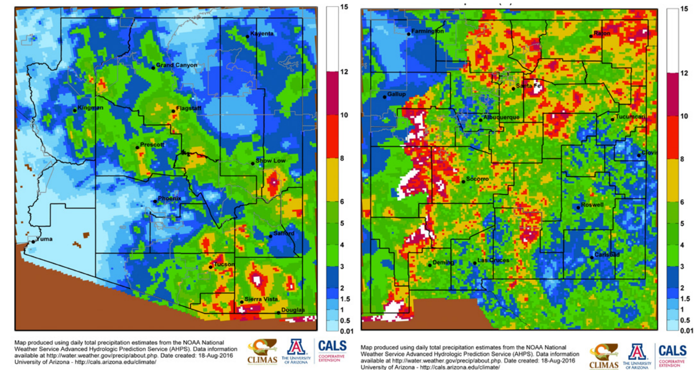


Figure 3a-b: Total Precipitation - Jun 15 - Aug 17

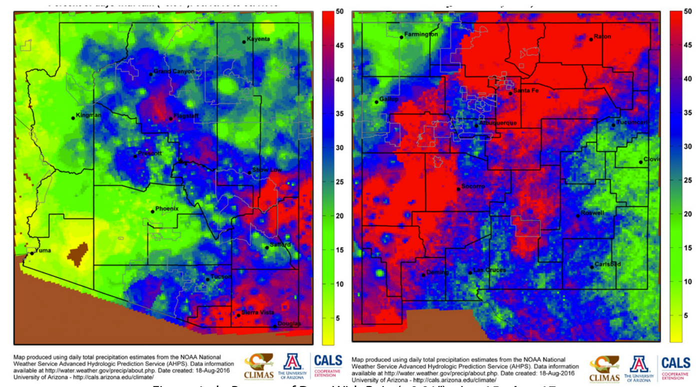


Figure 4a-b: Percent of Days With Rain (>0.01") - Jun 15 - Aug 17

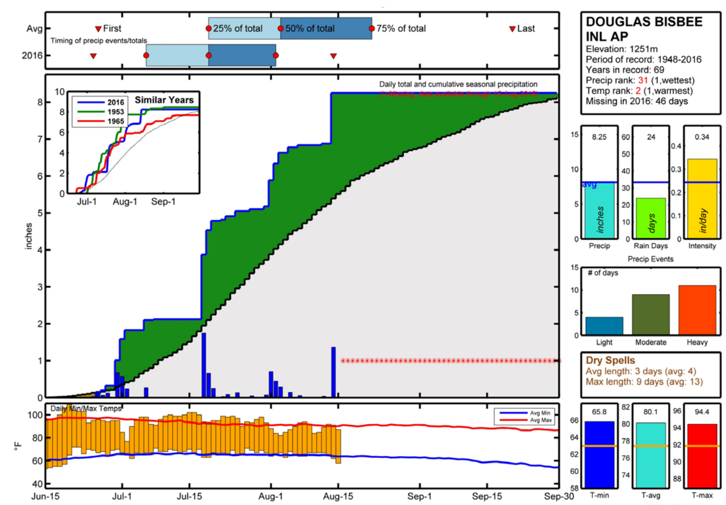


Figure 5a: 2016 Monsoon Precipitation to-Date - Douglas, AZ

Online Resources

Figures 5b-5g
Climate Science Applications Program
http://cals.arizona.edu/climate

SW Monsoon

Season Technical Summaries:

Technical summary plots were created for several stations across the region with high-quality long-term records. Email Mike Crimmins (crimmins@email.arizona.edu) to inquire about plots for additional stations or if you have any questions or suggestions on the plots.

For More Information, visit:

http://cals.arizona.edu/climate/misc/monsoon/monsoon_summaries.html

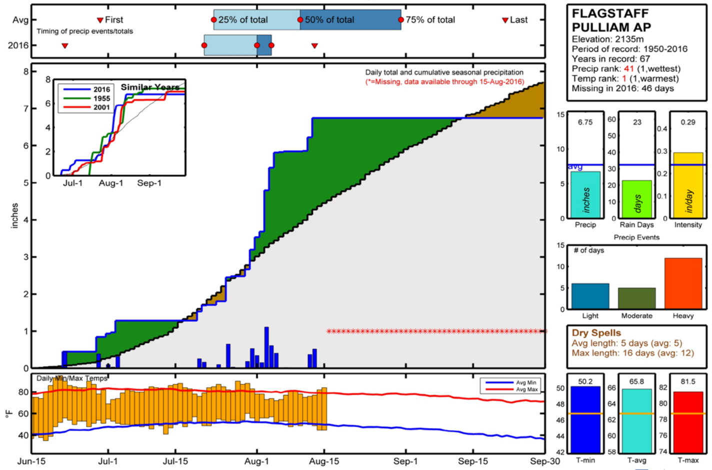


Figure 5b: 2016 Monsoon Precipitation to-Date - Flagstaff

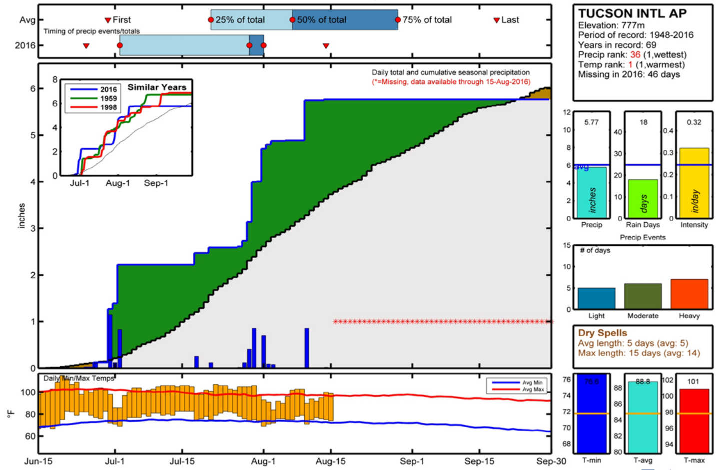


Figure 5c: 2016 Monsoon Precipitation to-Date - Tucson

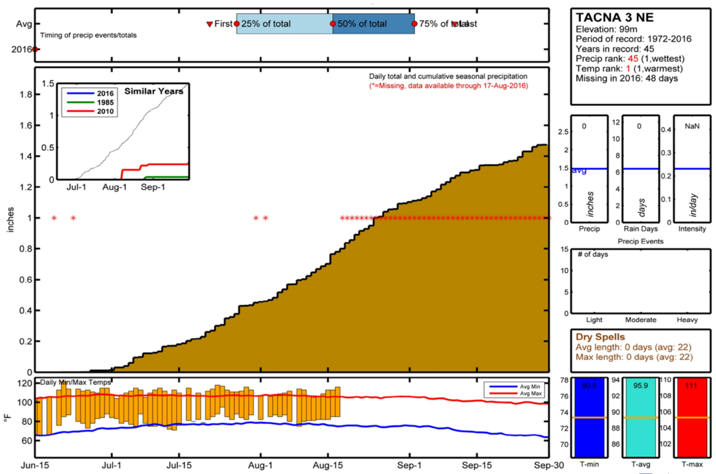


Figure 5d: 2016 Monsoon Precipitation to-Date - Tacna

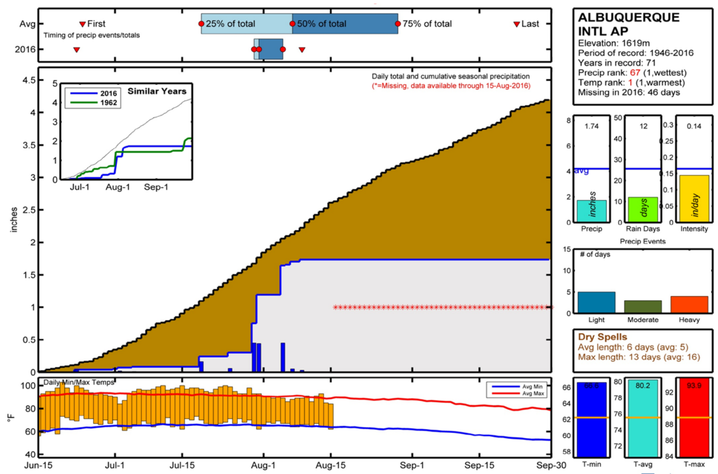


Figure 5e: 2016 Monsoon Precipitation to-Date - Albuquerque

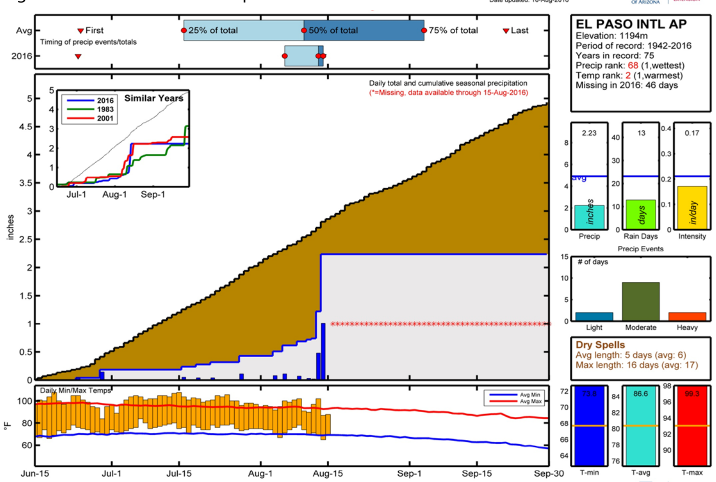


Figure 5f: 2016 Monsoon Precipitation to-Date - El Paso

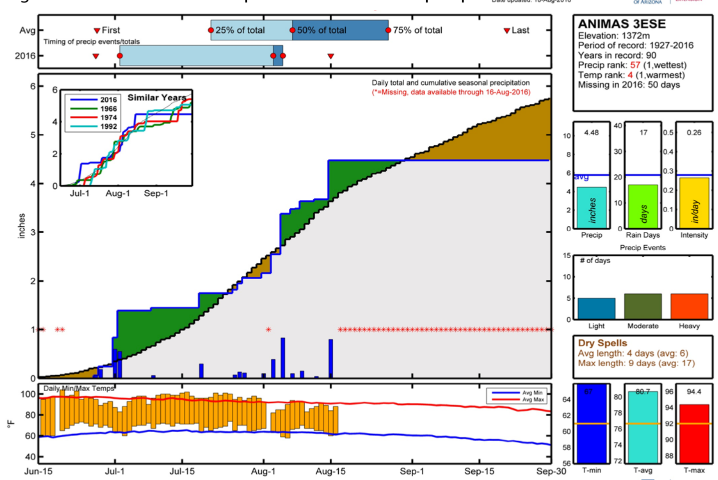
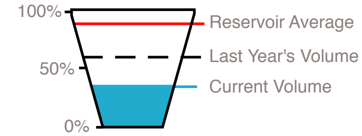


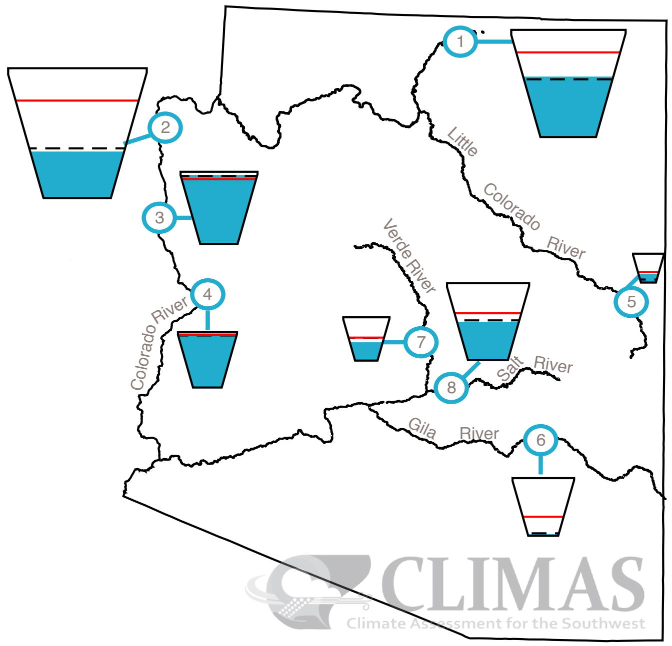
Figure 5g: 2016 Monsoon Precipitation to-Date - Animas 3ESE

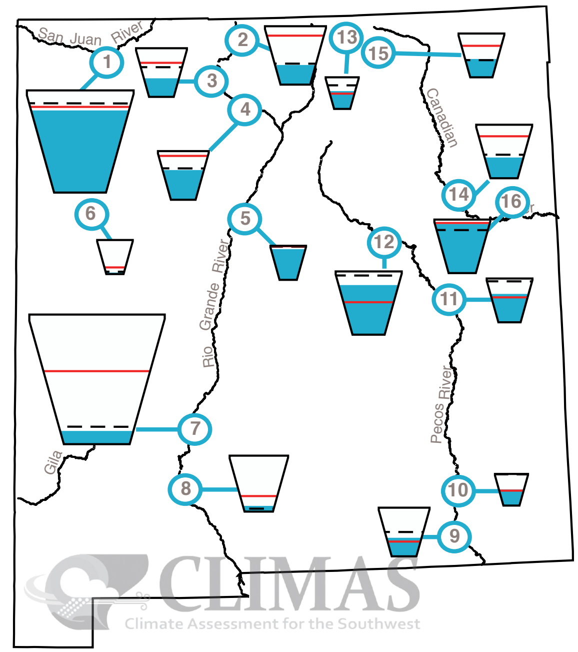
Reservoir Volumes

DATA THROUGH JULY 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	56%	13,575.5	24,322.0	-188.8
2. Lake Mead	36%	9,422.0	26,159.0	92.0
3. Lake Mohave	95%	1,721.0	1,810.0	-19.0
4. Lake Havasu	97%	602.4	619.0	4.6
5. Lyman	29%	8.6	30.0	-1.9
6. San Carlos	2%	16.6	875.0	-13.7
7. Verde River System	42%	120.9	287.4	-1.1
8. Salt River System	50%	1,019.2	2,025.8	-61.2

*KAF: thousands of acre-feet

Reservoir	Capacity	Current Storage*	Max Storage*	One-Month Change in Storage*
1. Navajo	80%	1,364.3	1,696.0	-72.8
2. Heron	34%	134.3	400.0	-1.5
3. El Vado	38%	73.0	190.3	-23.8
4. Abiquiu	61%	113.5	186.8**	-11.1
5. Cochiti	91%	45.6	50.0**	-0.5
6. Bluewater	5%	1.8	38.5	-0.1
7. Elephant Butte	9%	189.7	2,195.0	-108.6
8. Caballo	9%	28.7	332.0	-22.4
9. Lake Avalon	38%	1.7	4.5**	-0.4
10. Brantley	51%	21.4	42.2**	2.0
11. Sumner	65%	23.3	102.0**	21.1
12. Santa Rosa	78%	82.8	105.9**	-12.2
13. Costilla	56%	9.0	16.0	-2.9
14. Conchas	38%	97.0	254.2	-19.1
15. Eagle Nest	42%	32.8	79.0	-2.2
16. Ute Reservoir	91%	181	200	-4.0

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).