Contributors

Ben McMahan
SWCO Editor; Assistant Research Scientist
(CLIMAS, Institute of the Environment)

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

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October Southwest Climate Outlook

Precipitation and Temperature: Precipitation in September ranged from average to above average in New Mexico and from below average to much-above average in Arizona (Fig. 1a). September temperatures were warm throughout the region, ranging from much-above average to record warmest in Arizona and mostly above average to much-above average in New Mexico (Fig. 1b). Year-to-date precipitation was mostly average to below average in Arizona and New Mexico (Fig. 2a). Year-to-date temperatures were much-above average to record warmest across the region (Fig. 2b).

Monsoon Recap: The cumulative rainfall totals for June 15 – Sept. 30 blunt some of the monsoon variability seen across Arizona and New Mexico. Most of the region recorded normal to above-normal precipitation except for the Four Corners area, where rainfall ranged from below normal to record driest (Fig. 3). A closer look at statewide monthly totals and specific weather stations highlights the variability of the monsoon (see Monsoon Recap on pp. 4-5 for details).

Drought: Water-year precipitation (Oct. 1 to present) was below normal to record driest for most of Arizona and ranged from above normal to record driest in New Mexico. More broadly, most of the Southwest experienced below normal or lower precipitation totals, with the driest conditions centered on the Four Corners region (Fig. 4). Recent iterations of the US Drought Monitor have identified drought category improvements in southern Arizona as a result of tropical storm activity in early October (Fig. 5). This highlights the ongoing challenge of monitoring drought in an arid region, as extreme precipitation events can certainly help some locations make up their cumulative precipitation deficits, but it is less clear how localized intense precipitation and flooding improves long-term drought conditions. Despite the short-term upticks in precipitation observed locally, most of the Southwest is still affected by longer-term, cool-season precipitation deficits that have accumulated over the past few decades under persistent annual drought conditions in the Southwest.

Tropical Storms: The eastern North Pacific hurricane season has been very active, with 20 named storms at the time of this writing (Fig. 6), including nine major hurricanes (category 4 or above). NOAA forecasted 14-20 named storms and seven major hurricanes, so we're now at the high end of their prediction, and the season doesn't end until Nov 30. This year is currently tied with 1992 for the most intense Pacific hurricane season on record, with an Accumulated Cyclonic Energy of 295, and could easily break the record if any additional storms develop or persist. In the Southwest, recent notable events include widespread precipitation from tropical depression Nineteen-E Sept. 19-20, the swath of extreme precipitation observed with Tropical Storm Rosa in early October, and more widespread precipitation activity linked to Tropical Storm Sergio in mid-October (see Tropical Storm Activity Tracker on p. 6).

El Niño Tracker: Oceanic and atmospheric indicators are still within the range of ENSO-neutral conditions, but they are very likely moving towards an El Niño event in 2018. This shift is reflected in recent models and forecasts, which identify an approximately 75-percent chance of an El Niño event by the end of 2018. Most forecasts are calling for a weak event but a few suggest that a moderate event could develop (see El Nino tracker on p. 3 for details).

Precipitation and Temperature Forecast: The three-month outlook for November through January calls for increased chances of above-normal precipitation in Arizona and New Mexico (Fig. 7, top), and increased chances of above-average temperatures for the entire western United States (Fig. 7, bottom).

Tweet Oct 2018 SW Climate Outlook

CLICK TO TWEET

OCT2018 @CLIMAS_UA SW Climate Outlook, El Niño Tracker, Monsoon Wrap-Up, SW Tropical Storm Activity, AZ & NM Reservoir volumes https://bit.ly/2ykE3Ur #SWclimate #AZWX #NMWX

October 2018 SW Climate Outlook

Online Resources

Figures 1-2
National Centers for Environmental Information
ncei.noaa.gov

Figures 3-4
Western Regional Climate Center
wrcc.dri.edu

Figure 5
U.S. Drought Monitor
droughtmonitor.unl.edu

Figure 6
NWS National Hurricane Center
nhc.noaa.gov

Figure 7
NOAA - Climate Prediction Center
cpc.ncep.noaa.gov

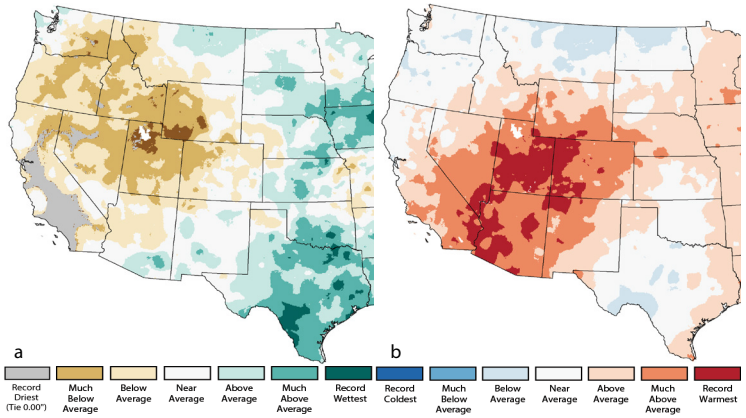


Figure 1: September 2018 Precipitation (a) & Temperature Ranks (b)

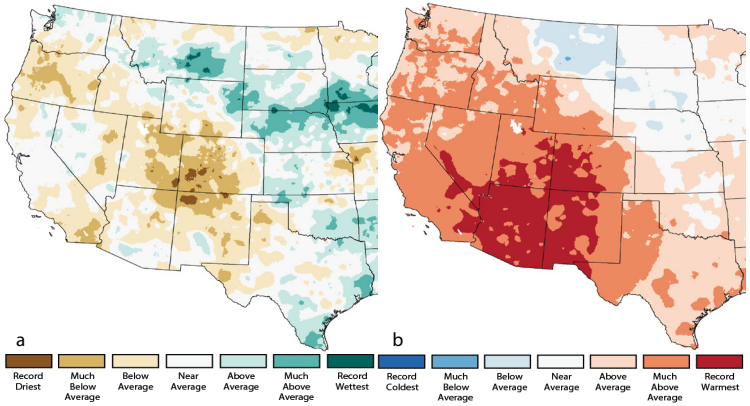


Figure 2: Jan-Sept 2018 Precipitation (a) & Temperature Ranks (b)

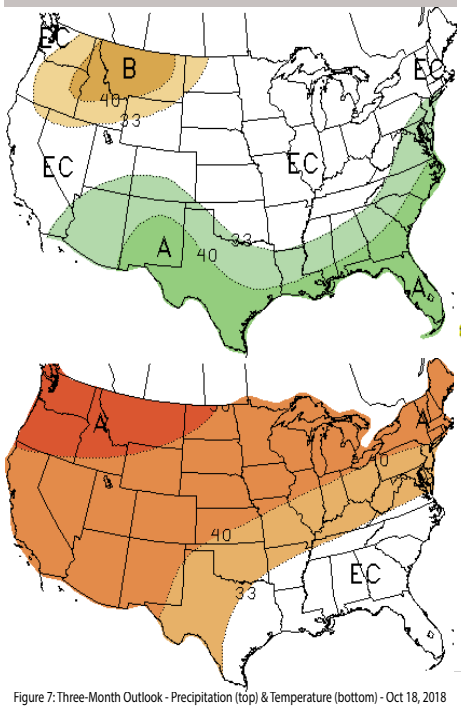


Figure 7: Three-Month Outlook - Precipitation (top) & Temperature (bottom) - Oct 18, 2018

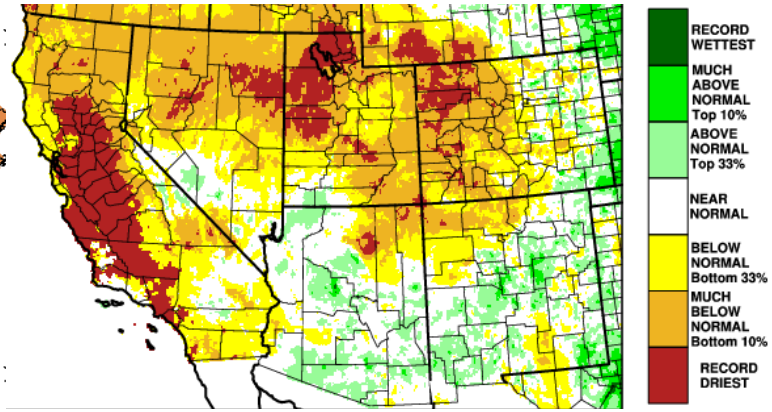


Figure 3: Jun - Sept 2018 Precipitation Rankings

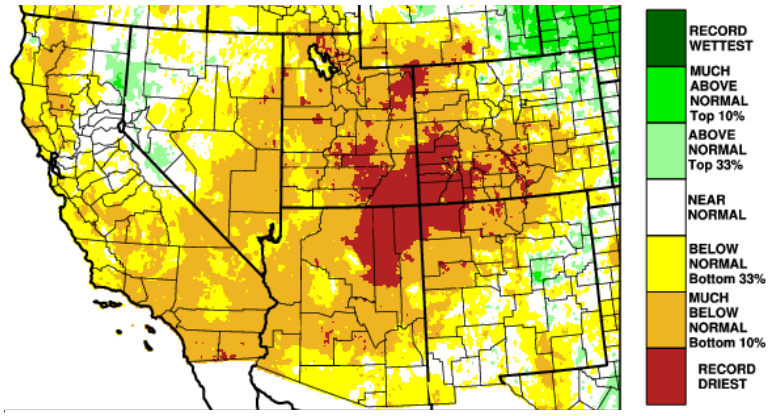


Figure 4: Water Year (Oct 2017 - Sept 2018) Precipitation Rankings

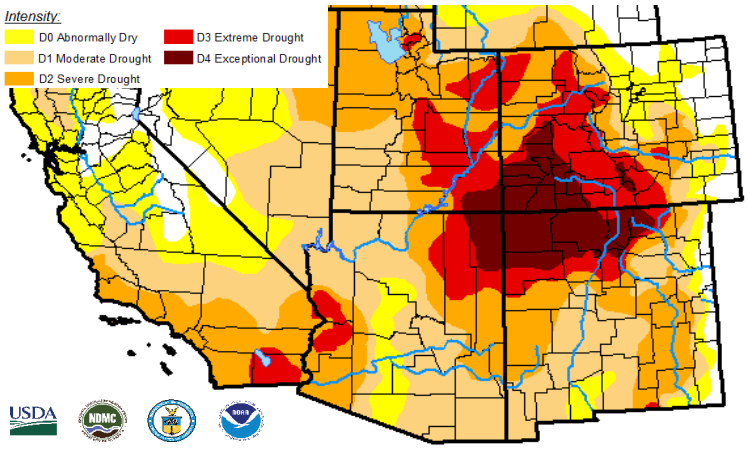


Figure 5: US Drought Monitor - Oct 16, 2018

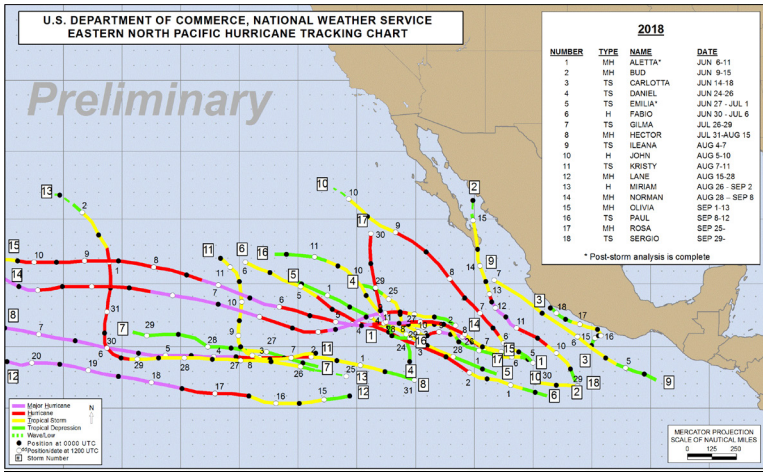


Figure 6: National Weather Service Eastern North Pacific Hurricane Tracking Chart

Online Resources

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

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

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

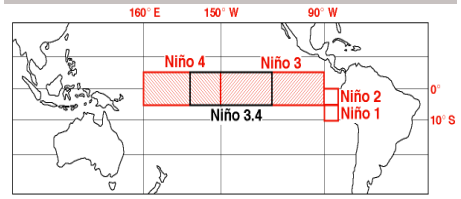
Figure 4
NOAA - Climate Prediction Center
cpc.ncep.noaa.gov

El Niño / La Niña

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

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

Equatorial Niño Regions



For more information: ncdc.noaa.gov/teleconnections/enso/indicators/sst/
Image Source: aoml.noaa.gov/

El Niño Tracker

Oceanic and atmospheric conditions are still within the range of ENSO-neutral (Figs. 1-2), but rising sea-surface temperatures (SSTs) and shifting atmospheric conditions are reflected in recent forecasts, which call for an El Niño event forming by the end of 2018 and lasting through the winter. On Oct. 11, the Japanese Meteorological Agency (JMA) identified continued ENSO-neutral conditions, but based on weakening easterlies and warming SSTs forecast a 70-percent chance of El Niño developing this fall. Similarly, on Oct. 9, weakening trade winds and warming oceanic temperatures were the basis for the Australian Bureau of Meteorology to elevate its ENSO Outlook to "El Niño Alert," with a 70-percent chance of its formation in 2018—three times the normal likelihood. On Oct. 11, the NOAA Climate Prediction Center (CPC) continued its El Niño watch, identifying neutral conditions at present but with a 70- to 75-percent chance of an El Niño event developing this winter. On Oct. 11, the International Research Institute (IRI) issued an ENSO Quick Look, which observed neutral conditions in the oceans and atmosphere now but with trends towards El Niño conditions in oceanic and atmospheric indicators. IRI suggests a nearly 75-percent chance of an El Niño event by the end of 2018 (Fig. 3). The North American Multi-Model Ensemble (NMME) stabilized over the past few months but continues to point toward a weak-to-borderline moderate El Niño by the end of the year (Fig. 4).

Summary: Despite persistent ENSO-neutral conditions this summer and early fall, outlooks and forecasts indicate the likely formation of an El Niño event before the year ends. These forecasts are informed by long-term climatological patterns and recent trends towards warming SSTs and shifting atmospheric conditions. There is effectively no chance of a La Niña event forming this winter, but ENSO-neutral conditions remain a possibility, albeit increasingly unlikely. The recent warming in SSTs and shifts in atmospheric circulation have kindled discussion about the possible intensity–rather than merely the existence–of this El Niño event. Cool-season precipitation totals (Oct – Mar) in the Southwest during previous El Nino events reveal considerable variability under weak events, including some drier-than-average seasonal totals. However, under moderate-intensity events, drier-than-average cool seasons have been rare. While it is too early to even call this an El Niño year with 100 percent certainty, much less predict its eventual intensity, we wait with great anticipation anything that might increase our chances of more winter rain. The sample size is small, but an El Niño of at least moderate intensity has been one of the more surefire pathways to a wetter-than-average Southwest winter (setting aside 2016 as the obvious outlier).

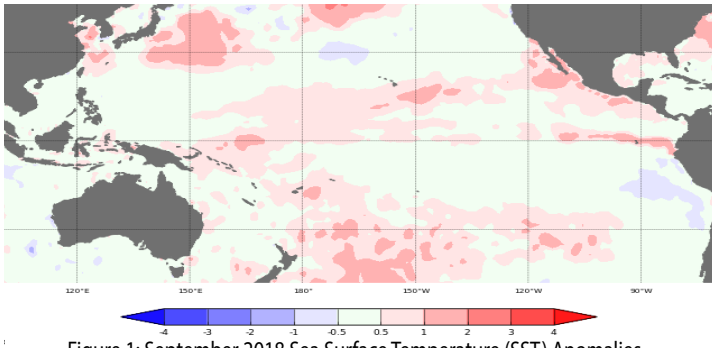


Figure 1: September 2018 Sea Surface Temperature (SST) Anomalies

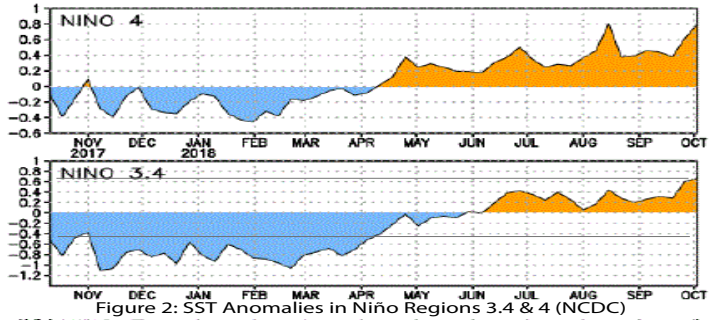


Figure 2: SST Anomalies in Niño Regions 3.4 & 4 (NCDC)

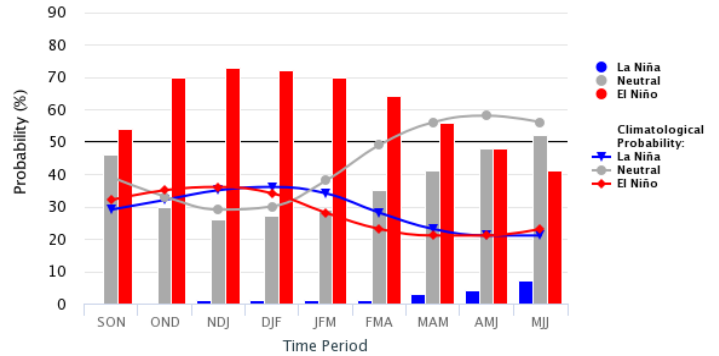


Figure 3: Early-Oct IRI/CPC Model-Based Probabilistic ENSO Forecast

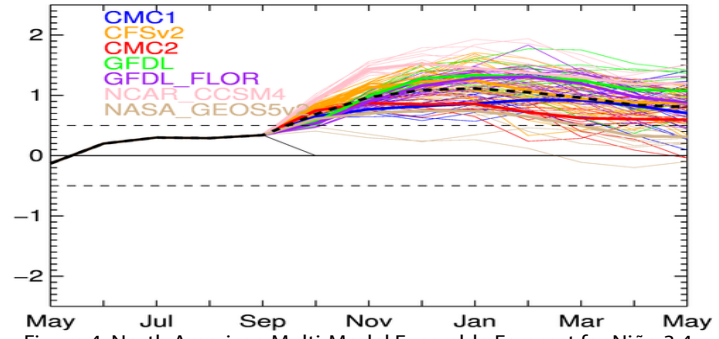


Figure 4: North American Multi-Model Ensemble Forecast for Niño 3.4

Online Resources

Figure 1
CLIMAS: Climate Assessment for the Southwest
climas.arizona.edu

Figure 1 Data: wrh.noaa.gov/twc/monsoon/monsoon_elp.php

Figure 2 Data: mesowest.utah.edu/

Figures 2-5
Western Regional Climate Center
wrcc.dri.edu

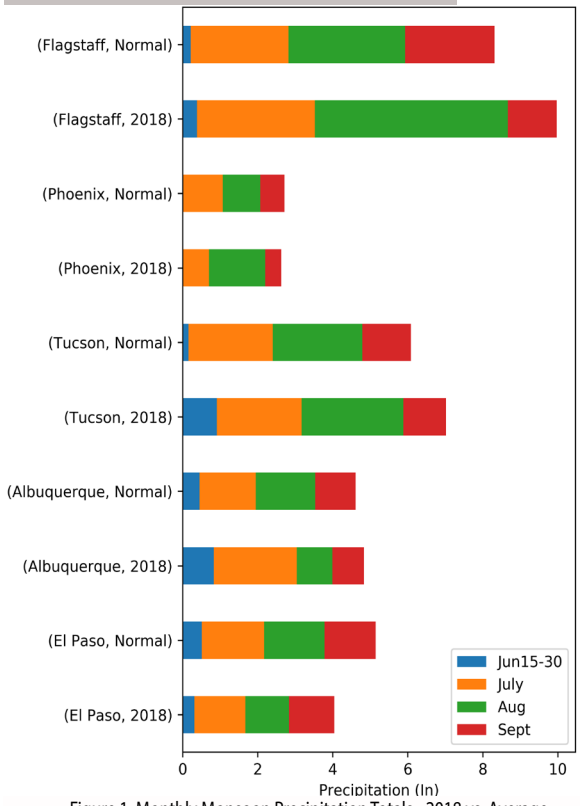


Figure 1: Monthly Monsoon Precipitation Totals - 2018 vs. Average

Monsoon Recap

The precipitation rankings for the months that encompass the monsoon period (see Fig. 3 on p. 2) smooth out the variability over space and time that is characteristic of this season. The cumulative totals for the monsoon for most of the major metropolitan areas in the region (Fig. 1) came in at or above average, with the exception of El Paso.

Monthly rankings show that June—which is typically dry, often with little actual precipitation at all in the Southwest—was wetter than normal across much of the borderlands region of Arizona and New Mexico (Fig. 2). This was almost entirely due to Tropical Storm Bud, which brought rain to the area in mid-June.

Widespread precipitation occurred across the Southwest in July, and while a few areas only received below-normal precipitation, most of the region was at or above normal for the month (Fig. 3).

August flipped that script, and while there were wide swaths of Arizona and New Mexico that received average to above-average rainfall, south-central New Mexico, parts of southern Arizona, and the Four Corners region in particular, lagged behind (Fig. 4).

In September, southeastern Arizona and the lower two-thirds of New Mexico received average to above-average precipitation, but this was largely due to the incursion of tropical moisture in the latter half of the month. Outside that area, the region was generally devoid of widespread precipitation, with the Four Corners region continuing to be the epicenter of below-average to record-driest conditions (Fig. 5).

Monsoon totals (Figs. 6a-b on p. 5) demonstrate the range of precipitation across the two-state region. Percent of normal precipitation (Figs. 7a-b) and percent of days with rain (Figs. 8a-b) describe aspects of the monsoon that shape local perceptions of the monsoon's performance (i.e. how much compared to normal, and whether rain fell in just a few intense days or over many less intense days).

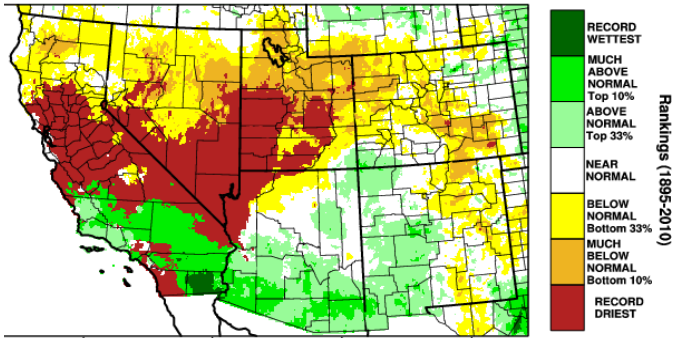


Figure 02: June 2018 Precipitation Rankings

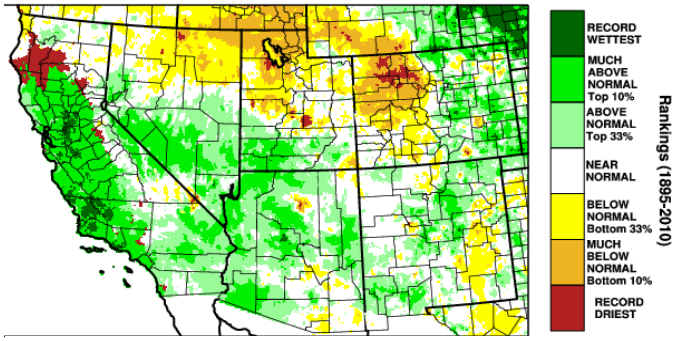


Figure 03: July 2018 Precipitation Rankings

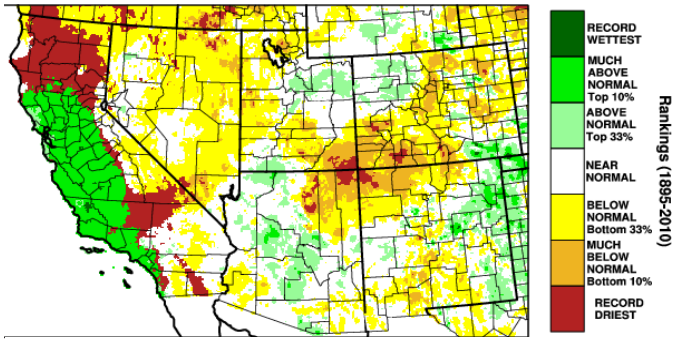


Figure 04: August 2018 Precipitation Rankings

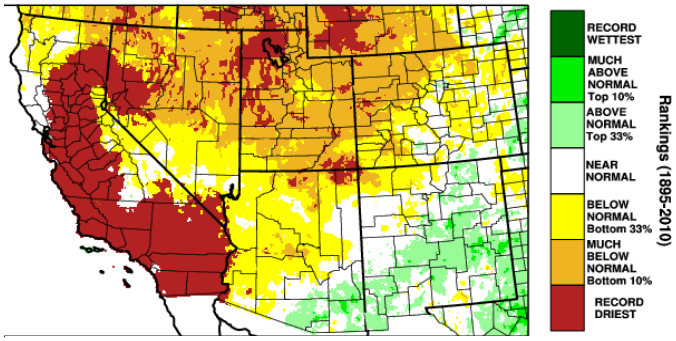


Figure 05: September 2018 Precipitation Rankings

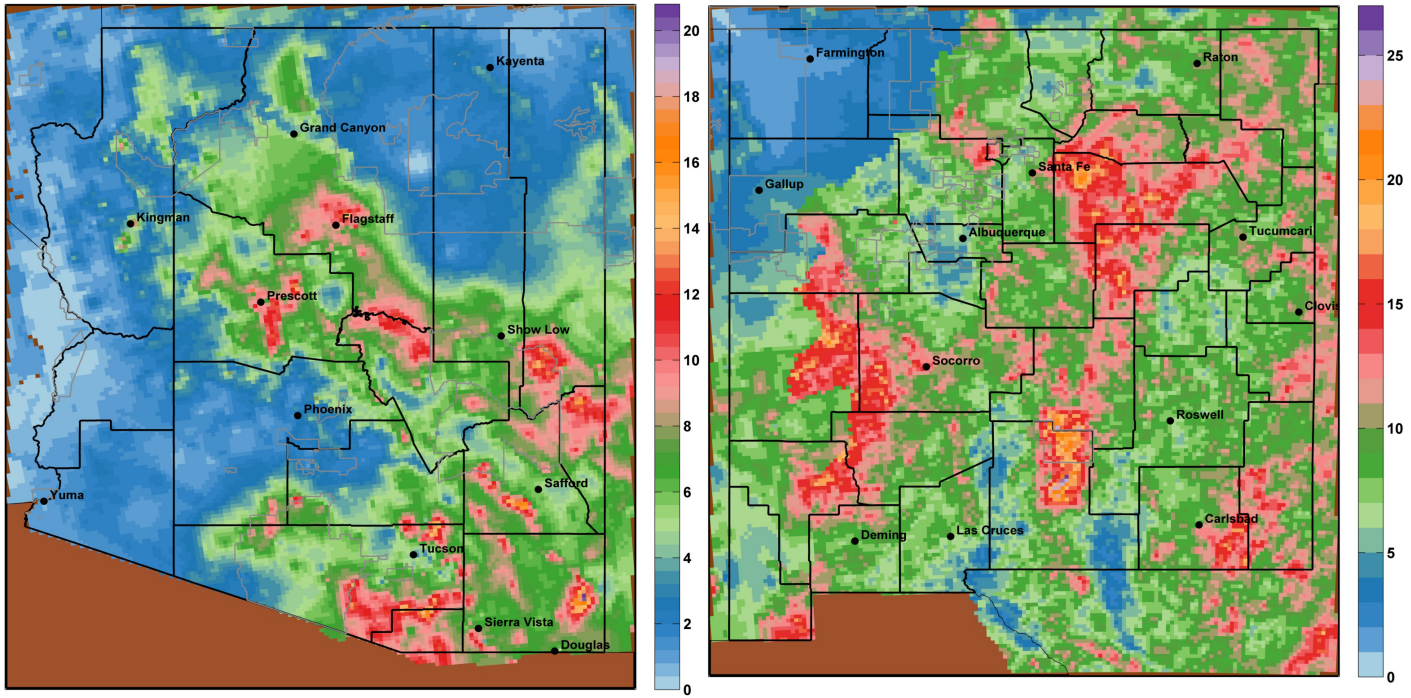
Online Resources

Figures 6-8
UA Climate Science Application Program
cals.arizona.edu/climate

Regional Monsoon Maps

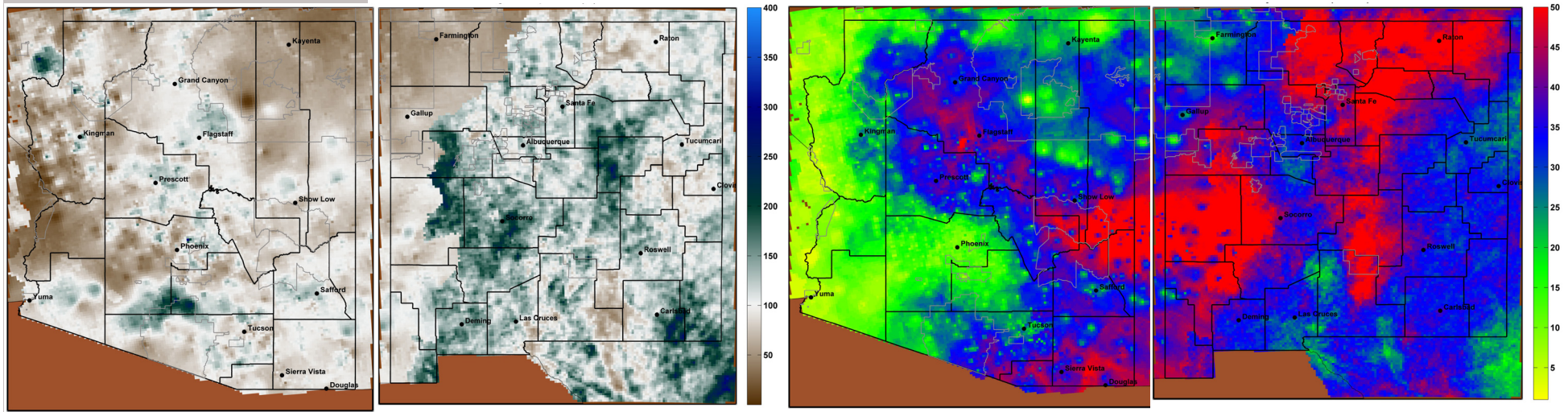
Seasonal totals to date show how varied precipitation can be across the Southwest (Fig. 3), while percent of normal precipitation (Fig. 4) puts the total into climatological context. Percent of days with rain (Fig. 5) captures another metric to characterize the variability of the monsoon.

Monsoon Recap



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: 01-Oct-2018 University of Arizona - http://cals.arizona.edu/climate/

Figure 6a-b: Total Precipitation - Jun 15 - Sep 30, 2018



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: 01-Oct-2018 University of Arizona - http://cals.arizona.edu/climate/

Figure 7a-b: Percent of Normal Precipitation - Jun 15 - Sep 30, 2018

Figure 8a-b: Percent of Days With Precipitation (>0.01") - Jun 15 - Sep 30, 2018

Online Resources

Figures 1-4
CLIMAS: Climate Assessment for the Southwest
climas.arizona.edu

Data: prism.nacse.org

Hurricane Tracks (Fig 6 from p. 2)
NWS National Hurricane Center
nhc.noaa.gov

**For an extended discussion of TS Bud, the monsoon, and monsoon statistics, check out the Southwest Climate Podcast - CLIMAS' monthly podcast on weather and climate in the Southwest*

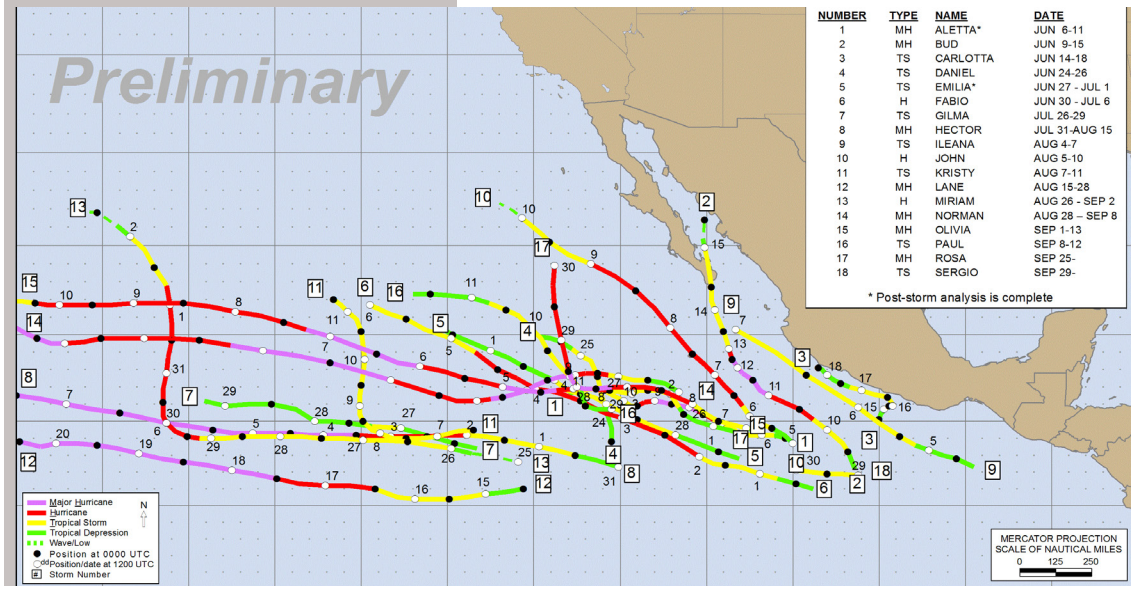
climas.arizona.edu/podcasts/climas-southwest-climate-podcast

Tropical Storm Tracker

Atlantic hurricanes Florence and Michael have understandably been the focus of attention this year, but as discussed on page 1, 2018 has been an extremely active year for tropical storms in the eastern North Pacific. While most of the storms expended most or all of their energy over the Pacific, a few had notable impacts on the Southwest.

In mid-June, Tropical Storm Bud caused widespread precipitation across the Southwest just as the monsoon began, kickstarting cumulative monsoon precipitation totals, even as some argued it should not be included as part of the monsoon* (Fig. 1). In September, Tropical depression Nineteen-E brought widespread precipitation to the Southwest (Fig. 2) and was a major contributor to that month's above-normal precipitation (see Fig. 5 on p. 4). October has seen two events (thus far) of notably different character. Tropical Storm Rosa brought intense precipitation to the borderlands region of Arizona and up to Phoenix (Fig. 3) at the beginning of the month, resulting in severe flooding in both regions, and one week later, Tropical Storm Sergio brought more widespread but less-intense precipitation to southern Arizona and parts of New Mexico (Fig. 4).

With an official end to the season not until Nov. 30, it remains to be seen how many more tropical storms might bring additional rainfall to the Southwest this fall.



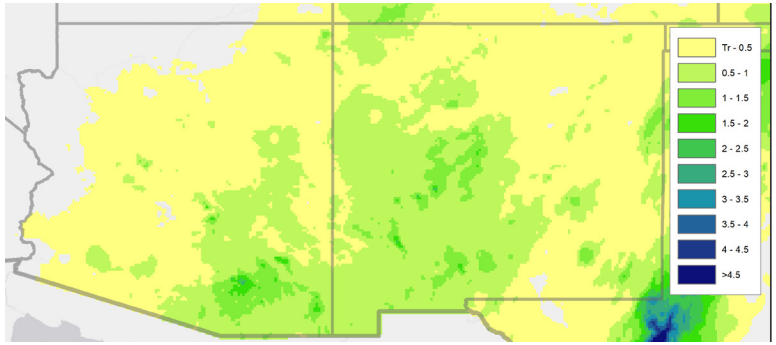


Figure 01: Precipitation June 15 - June 17 (TS Bud)

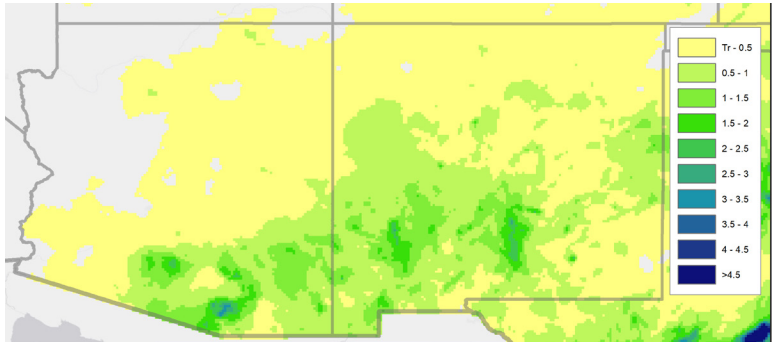


Figure 02: Precipitation Sept 20 - Sept 21 (TD Nineteen-E)

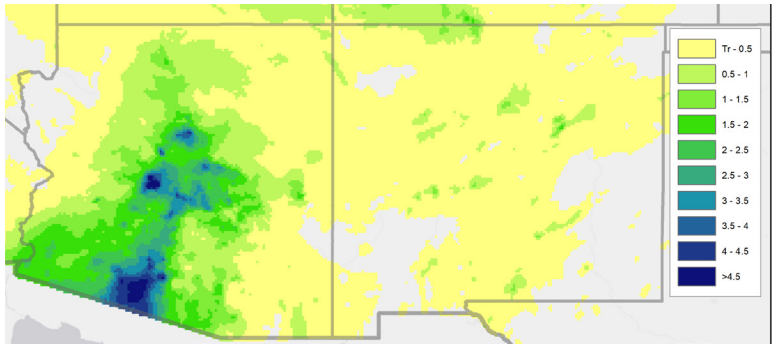


Figure 03: Precipitation Oct 1 - Oct 3 (TS Rosa)

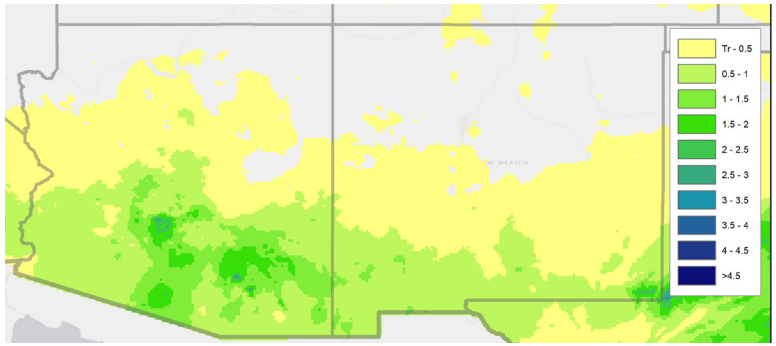


Figure 04: Precipitation Oct 13 - Oct 14 (TS Sergio)

Online Resources

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

www.wcc.nrcs.usda.gov/BOR/basin.html

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).

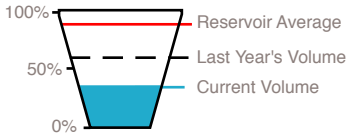
The table details more exactly the current capacity (listed as a percent of maximum storage). Current and maximum storage are given in thousands of acre-feet for each reservoir. One acre-foot is the volume of water sufficient to cover an acre of land to a depth of 1 foot (approximately 325,851 gallons).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

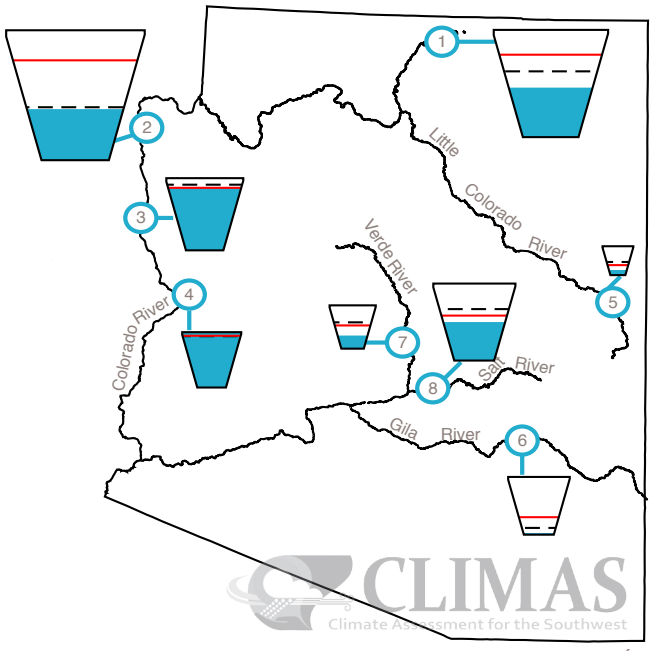
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS).

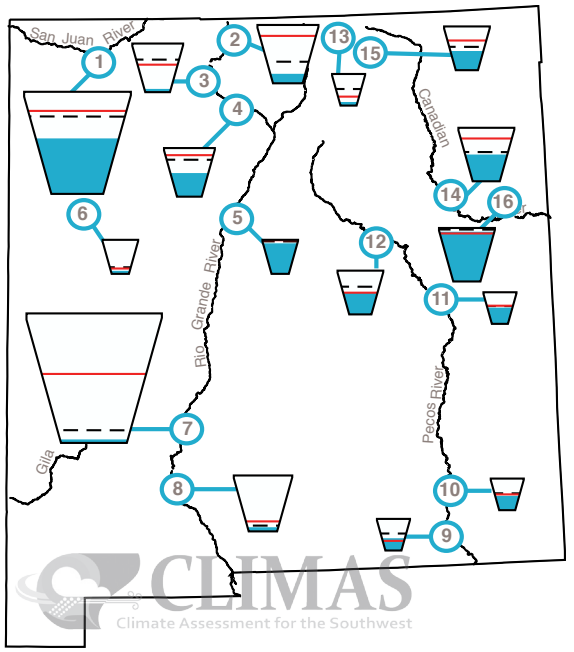
Reservoir Volumes

DATA THROUGH OCT 1, 2018

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	45%	11,027.7	24,322.0	-449.7
2. Lake Mead	38%	9,870.0	26,159.0	-48.0
3. Lake Mohave	86%	1,559.0	1,810.0	-120.0
4. Lake Havasu	97%	600.8	619.0	27.3
5. Lyman	16%	4.7	30.0	-0.6
6. San Carlos	1%	7.0	875.0	4.4
7. Verde River System	29%	83.5	287.4	-1.8
8. Salt River System	48%	974.8	2,025.8	-44.6

*KAF: thousands of acre-feet

* in KAF = thousands of acre-feet

Reservoir	Capacity	Current Storage*	Max Storage*	One-Month Change in Storage*
1. Navajo	54%	919.3	1,696.0	-72.0
2. Heron	16%	64.4	400.0	-34.5
3. El Vado	7%	12.5	190.3	1.5
4. Abiquiu	48%	90.0	186.8	8.1
5. Cochiti	90%	44.8	50.0	-0.3
6. Bluewater	9%	3.4	38.5	-0.1
7. Elephant Butte	3%	58.7	2,195.0	-26.7
8. Caballo	7%	23.9	332.0	-5.9
9. Lake Avalon	38%	1.7	4.5	-0.4
10. Brantley	45%	18.9	42.2	6.2
11. Sumner	51%	18.2	35.9	-3.7
12. Santa Rosa	49%	52.1	105.9	-7.5
13. Costilla	11%	1.8	16.0	-0.8
14. Conchas	50%	126.7	254.2	-10.2
15. Eagle Nest	44%	34.6	79.0	-1.3
16. Ute Reservoir	94%	187	200	0.0

Online Resources

Figure 1
Climate Program Office
cpo.noaa.gov

RISA Program Homepage

http://cpo.noaa.gov/Meet-the-Divisions/Climate-and-Societal-Interactions/RISA

UA Institute of the Environment

environment.arizona.edu

New Mexico Climate Center

weather.nmsu.edu

CLIMAS Research & Activities

CLIMAS Research

climas.arizona.edu/research

CLIMAS Outreach

climas.arizona.edu/outreach

Climate Services

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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.

What does CLIMAS do?

The CLIMAS team and its 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.

CLIMAS Colloquium Series - Oct 12, 2018

George Frisvold: Update on the Colorado River Shortage Declaration:Planning, Responses and Consequences

youtu.be/M890Bep4DEg

Ben McMahan: Drought/Climate Vulnerabilities and Priorities in Southern Arizona -

youtu.be/o2cO91ZeFeU

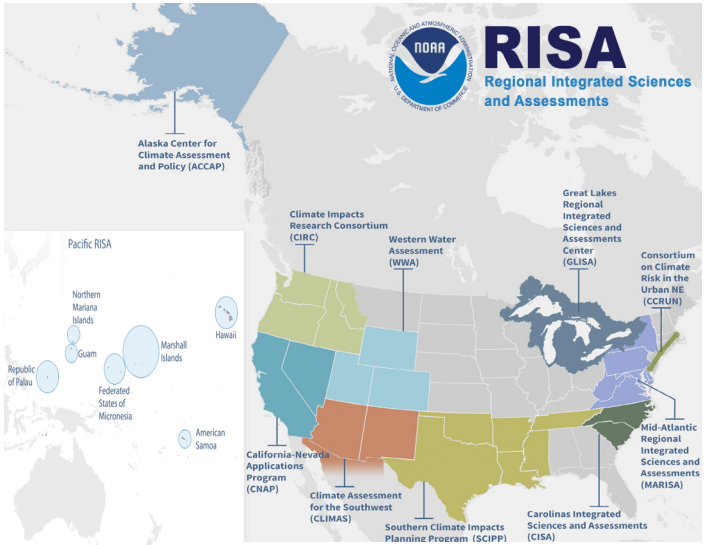

Figure 1: NOAA Regional Integrated Sciences and Assessments Regions

September 2018 SW Climate Podcast

Monsoon 2018 - The "Increased Chance of Above-Normal Expectations" Edition - Climatology(plus) Wins!

In the September 2018 edition of the CLIMAS Southwest Climate Podcast, Mike Crimmins and Zack Guido look back at the monsoon, and talk about how it fired up and unfolded, some pretty impressive rain totals in the Southwest, and who might have been left out at times. At the time the podcast was recorded, there were technically still a few days left in the monsoon, but during the 'transition' season of September, it takes some special circumstances (or a tropical storm!) to bring widespread precipitation to the region. Conveniently, such an event had just happened (on/around Sept 19), so Mike and Zack discuss this event, along with monsoon precipitation totals. They wrap up with a discussion of "the bet" and preview next month's podcast when they'll dive back into ENSO and the likely El Niño that's been brewing for a few months now.

https://bit.ly/2xBo3gy

Note: the podcast was recorded before tropical storms Rosa and Sergio brought additional precipitation to the Southwest.