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September Southwest Climate Outlook

Precipitation and Temperature: Precipitation in August ranged from much-below average to average in New Mexico and from much-below average to above average in Arizona (Fig. 1a). August temperatures were mostly above average across Arizona and New Mexico, with swaths of much-above average and isolated locations of record-warmest conditions (Fig. 1b). Most of the daily temperature anomalies (deviations above or below the average temperature) have been warmer across the region since July 1 (Fig. 2). Summer (June-July-August) precipitation has varied considerably, from mostly average to below average in New Mexico, and from mostly average to above average in Arizona (Fig. 3).

Monsoon Tracker: Every monsoon is different, and this year has been characterized by abundant moisture available over much of the period, yet with a wide variety of precipitation totals (see Monsoon Tracker for details). This variability is characteristic of the monsoon, but we have seen fewer extended breaks in the monsoon compared to previous years.

Drought: Water-year precipitation continues to highlight persistent moisture deficits in Arizona and much of New Mexico–particularly in the Four Corners region (Fig. 4). These conditions are reflected in the Sept. 18 US Drought Monitor, which identifies exceptional drought conditions (D4) in northeastern Arizona and northern New Mexico as well as less-intense drought designations (D1-D3) across the remainder of the two-state region (Fig. 5). The overall drought picture in the USDM characterization is actually improved from a few months ago, with smaller areas characterized as experiencing exceptional drought, but this in part reflects the highly localized nature of monsoon precipitation. The storms brought drought relief to localized areas, but others received below-average precipitation during the same time period. Despite the short-term upticks in precipitation observed locally, the entire region is still impacted by the longer-term, cool-season precipitation deficits that have characterized drought conditions in the Southwest over much of the past few decades.

Tropical Storms: The scale and impact of Hurricane Florence in the Carolinas has occupied much of the storm-related attention recently, but the eastern North Pacific hurricane season has been quite active, with 16 named storms at the time of this writing, including 6 major hurricanes (category 4 or above). 2018 is currently the fourth most intense Pacific hurricane season, with an Accumulated Cyclonic Energy of 218 (the record is 295 in 1992). These storms have generally moved westward into the Pacific Ocean (Fig. 5), but we are approaching the part of the season when these storms are more likely to curve back into the Southwest, where they can provide supplemental moisture for convective activity or even drive precipitation events directly, as we have seen in the past with Norbert, Odile, and others.

El Niño Tracker: ENSO-neutral conditions still characterize the oceanic and atmospheric indicators, but the most recent models and forecasts continue to point toward the emergence of a fall-into-winter El Niño event as the most likely outcome. However, expectations have been scaled back from earlier predictions, with the recent forecasts suggesting a weak event rather than a possible moderate-strength event. Adding further uncertainty, the possibility also remains of an El Niño event fizzling out before it even gets started, with neutral conditions simply continuing through the fall and winter. Whether weak El Niño or ENSO-neutral, both scenarios give the Southwest a better chance of improving on the drier-than-normal conditions associated with La Niña events.

Precipitation and Temperature Forecast: The three-month outlook for September through December 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 Sept 2018 SW Climate Outlook

CLICK TO TWEET

SEP2018 @CLIMAS_UA SW Climate Outlook, El Niño Tracker, Monsoon Tracker, AZ & NM Reservoir volumes https://bit.ly/2PT0upV #SWclimate #AZWX #NMWX #SWCO

September 2018 SW Climate Outlook

Online Resources

Figures 1,3
National Centers for Environmental Information
ncei.noaa.gov

Figure 2
Climate Assessment for the SW
climas.arizona.edu

Figure 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

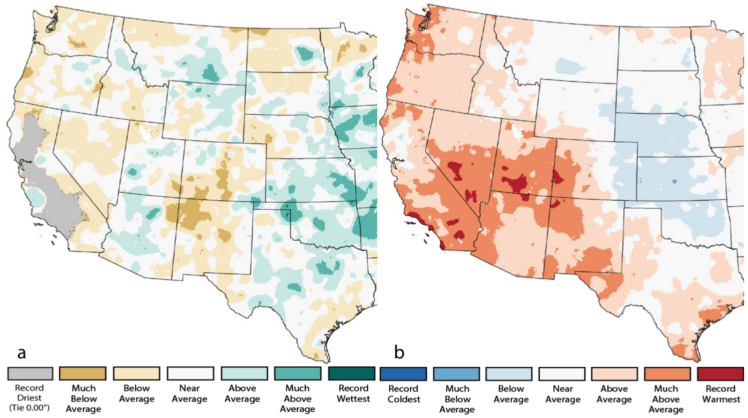


Figure 1: August 2018 Precipitation (a) & Temperature Ranks (b)

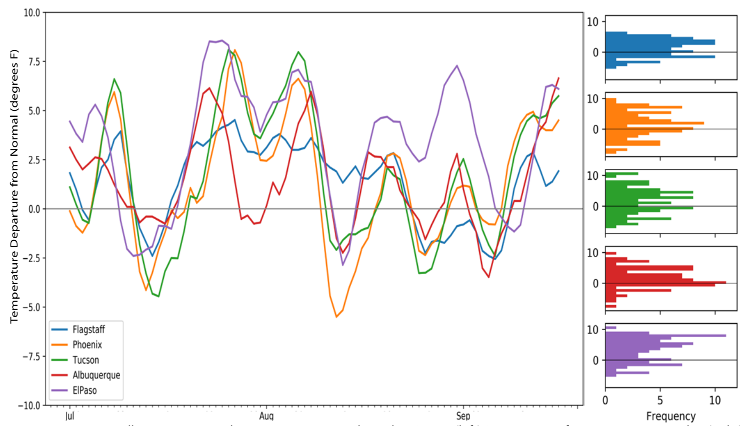


Figure 2: Five Day Rolling Average - Daily Temperature Anomalies Jul 1 - Sep 17 (left) & Frequency of Temperature Anomalies (right)

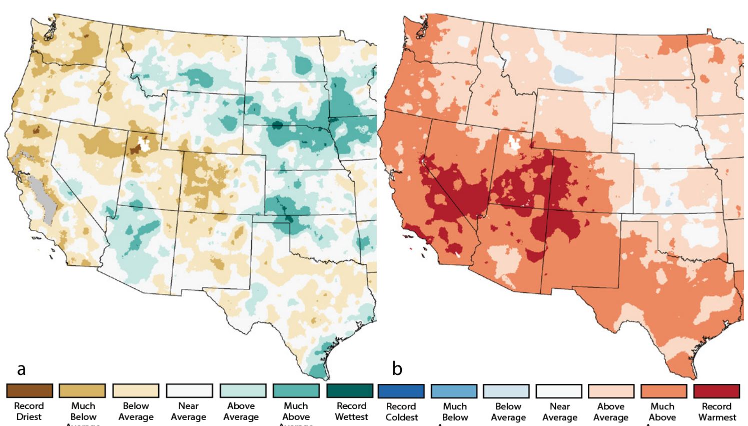


Figure 3: Jun-Aug 2018 Precipitation (a) & Temperature Ranks (b)

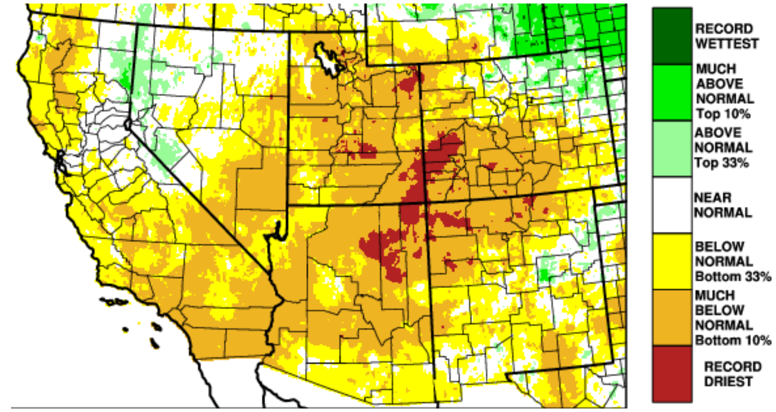


Figure 4: Water Year (Oct 2017 - Aug 2018) Precipitation Rankings

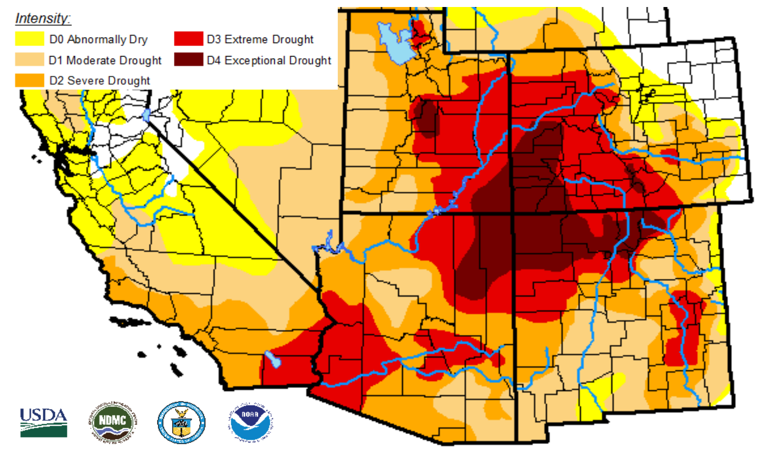


Figure 5: US Drought Monitor - Sept 18, 2018

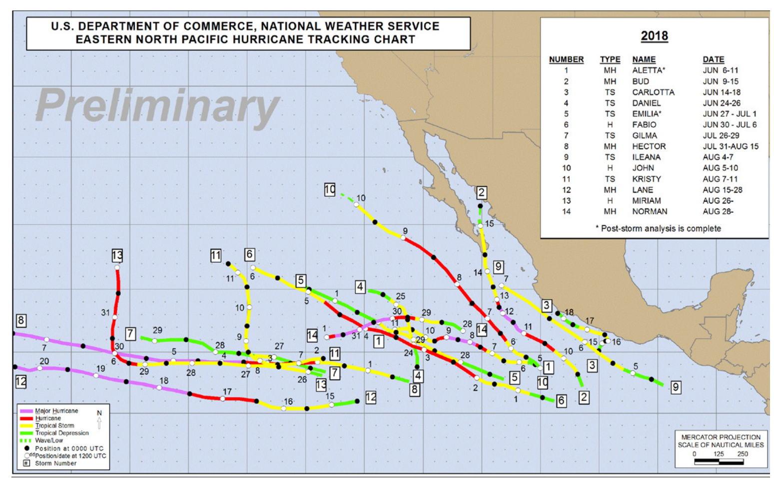


Figure 6: National Weather Service Eastern North Pacific Hurricane Tracking Chart

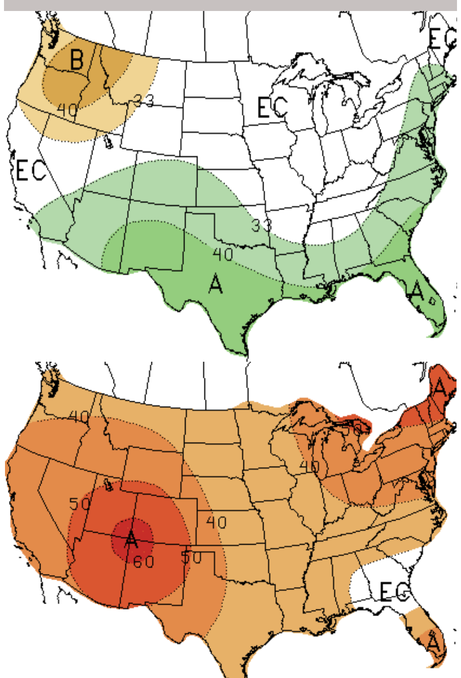


Figure 7: Three-Month Outlook - Precipitation (top) & Temperature (bottom) - Sep 20, 2018

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

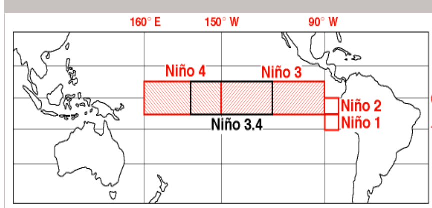
Figure 4
NOAA - Climate Prediction Center
cpc.ncep.noaa.gov

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/

ENSO Tracker

With little change from last month, the Southwest remains in an ENSO holding pattern. Oceanic and atmospheric conditions are still within the range of ENSO-neutral (Figs. 1-2), but the forecasts point toward the likely emergence of an El Niño event this fall and lasting into the winter. On Sept. 10, the Japanese Meteorological Agency (JMA) identified continued ENSO-neutral conditions in oceanic and atmospheric indicators, with a 60-percent chance of El Niño developing this fall. On Sept. 11, the Australian Bureau of Meteorology maintained its “El Niño Watch;” most indicators are within the range of neutral, but models suggest a warming tropical Pacific in the coming months. The agency predicts a 50-percent chance of El Niño formation by the end of this year. Similarly, on Sept. 13, the NOAA Climate Prediction Center (CPC) continued its El Niño watch, identifying persistent neutral conditions now but with seasonal outlooks and models predicting the emergence of an El Niño later this year. Based on these models, the current forecasts call for a 50- to 55-percent chance of an El Niño event developing this fall, and a 65- to 70-percent chance of El Niño conditions this winter. On Sept. 13, the International Research Institute (IRI) issued its ENSO Quick Look, also indicating continued neutral conditions in the oceans and atmosphere currently, but calling for a nearly 70-percent chance of an El Niño event by the end of 2018 (Fig. 3). The North American Multi-Model Ensemble (NMME) has stabilized over the past few months but continues to indicate warmer-than-average ocean temperatures and the likelihood of a weak El Niño event by the end of 2018 (Fig. 4).

Summary: Despite persistent ENSO-neutral conditions, most outlooks have held steady in predicting the most likely outcome for late 2018 to be the formation of an El Niño event. With forecast probabilities between 50 and 70 percent and the continued discussion of this event, it starts to feel as though an El Niño is likely. Given the effectively zero-percent chance of a La Niña event, the remainder of these forecast probabilities call for an ENSO-neutral fall and winter (2018-2019), with a 30- to 50-percent chance of neutral conditions through early 2019. A few of the forecasts noted that while the current oceanic and atmospheric indicators are neutral, they are seeing something in the models that gives them (relative) confidence of an El Niño event by the end of 2018. Such events have fizzled before, however, so given the relative weak strength of the current trends towards El Niño conditions, we would be wise to just wait and see how conditions develop over the next few months.

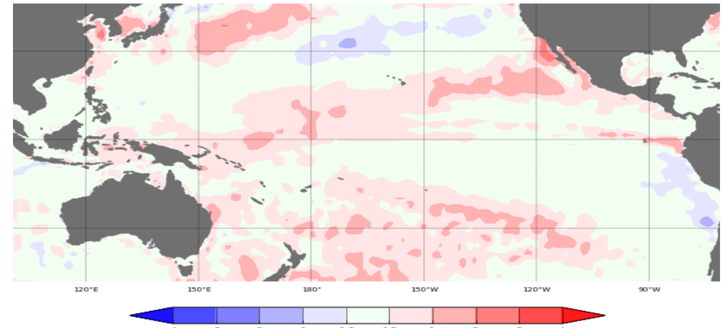


Figure 1: August 2018 Sea Surface Temperature (SST) Anomalies

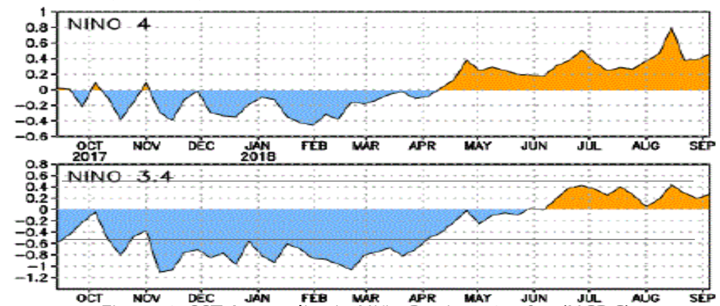


Figure 2: SST Anomalies in Niño Regions 3.4 & 4 (NCDC)

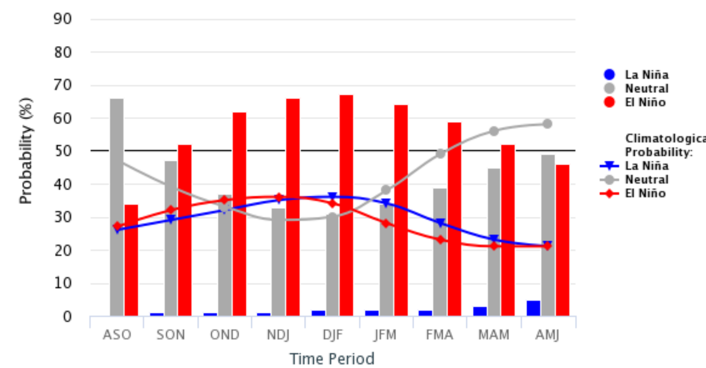


Figure 3: Early-Sep IRI/CPC Model-Based Probabilistic ENSO Forecast

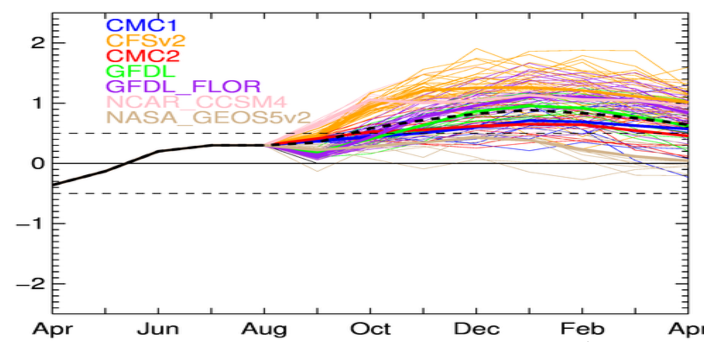


Figure 4: North American Multi-Model Ensemble Forecast for Niño 3.4

Online Resources

Figures 1-2
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/

Monsoon Tracker

Monsoon precipitation varies considerably in space and time across the Southwest, as illustrated by monthly totals for various stations. (Fig. 1). Statewide patterns highlight widespread areas of both above- and below-average totals (see Fig. 4 on p. 5). The Fig. 2 plots of daily precipitation, temperature, and dewpoint temperature for the same stations as Fig. 1 capture the intermittent nature of monsoon precipitation as well as the persistent elevated dewpoint most locations experienced this summer.

In many years, breaks in monsoon activity (sometimes for extended periods) occur, characterized by decreased humidity and increased temperatures. While we had fewer such intervals this year, that was no indicator of consistent precipitation (El Paso and Phoenix are both good examples). As noted last month, sustained periods of high dewpoints without precipitation led to extreme heat warnings in the region and persistent warm overnight temperatures. Without storm-induced cooling, elevated dewpoint temperatures can be downright miserable, especially for households that rely on evaporative coolers for interior climate control.

At the time of this writing (Sept. 20, 2018), southern Arizona had just experienced a surge in tropical moisture that drove storm activity on Sept. 18-19, with preliminary reports of over three inches of rain in some locations, and widespread precipitation across southern Arizona (more on this and tropical storm activity next month).

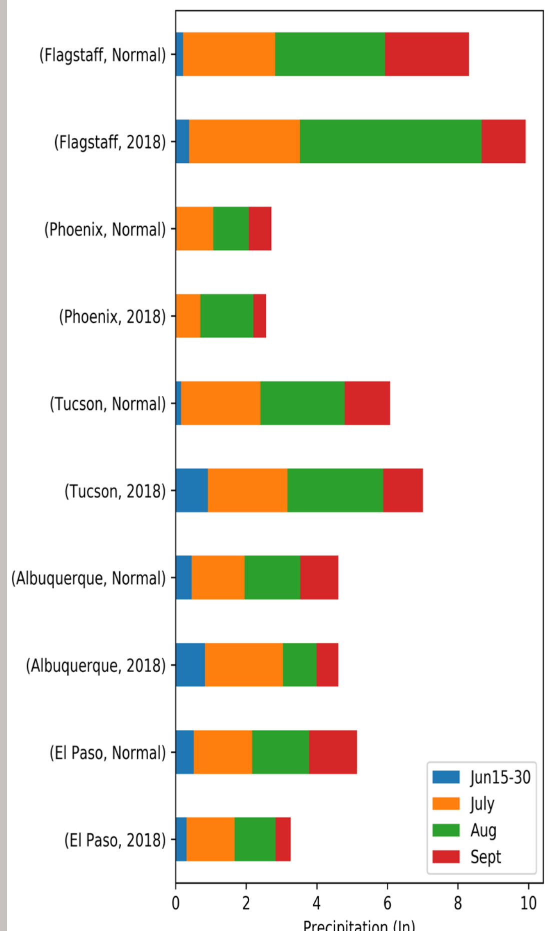


Figure 1: Monthly Monsoon Precipitation Totals - 2018 vs. Average

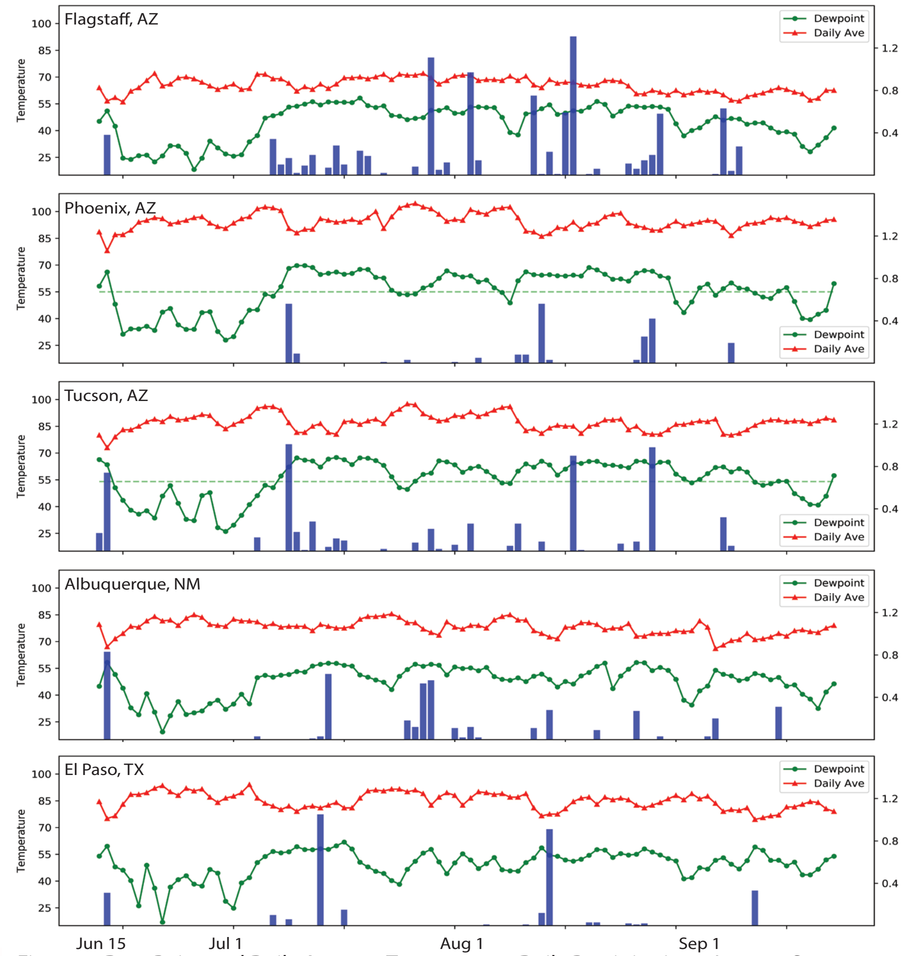


Figure 2: Dew Point and Daily Average Temperature, Daily Precipitation - Jun 15 - Sep 16, 2018

Online Resources

Figures 3-5
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 Tracker

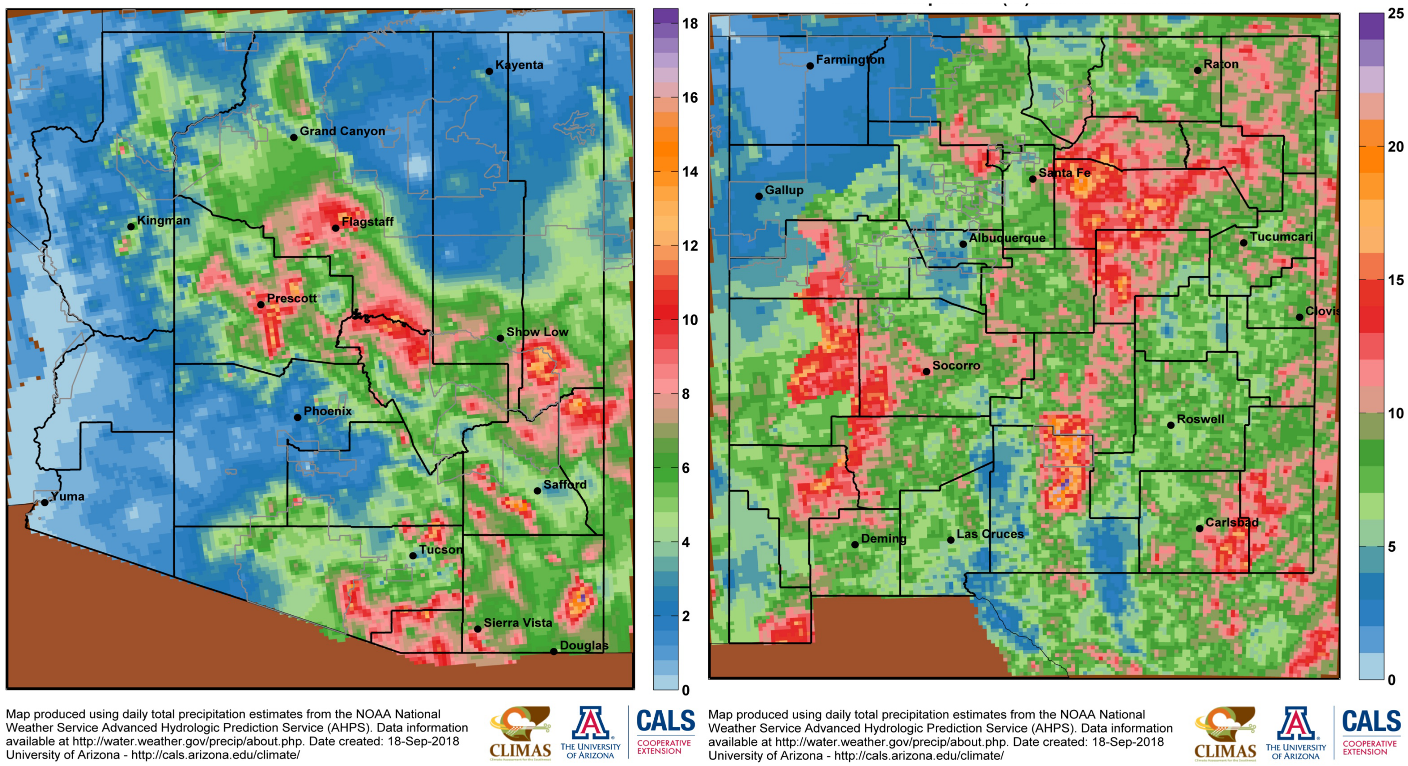


Figure 3a-b: Total Precipitation - Jun 15 - Sep 17, 2018

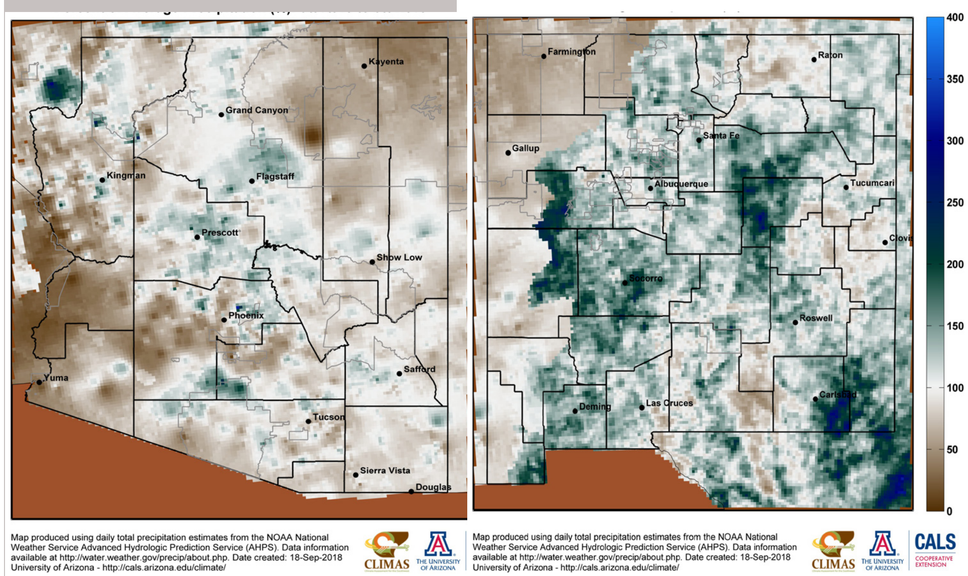


Figure 4a-b: Percent of Normal Precipitation - Jun 15 - Sep 17, 2018

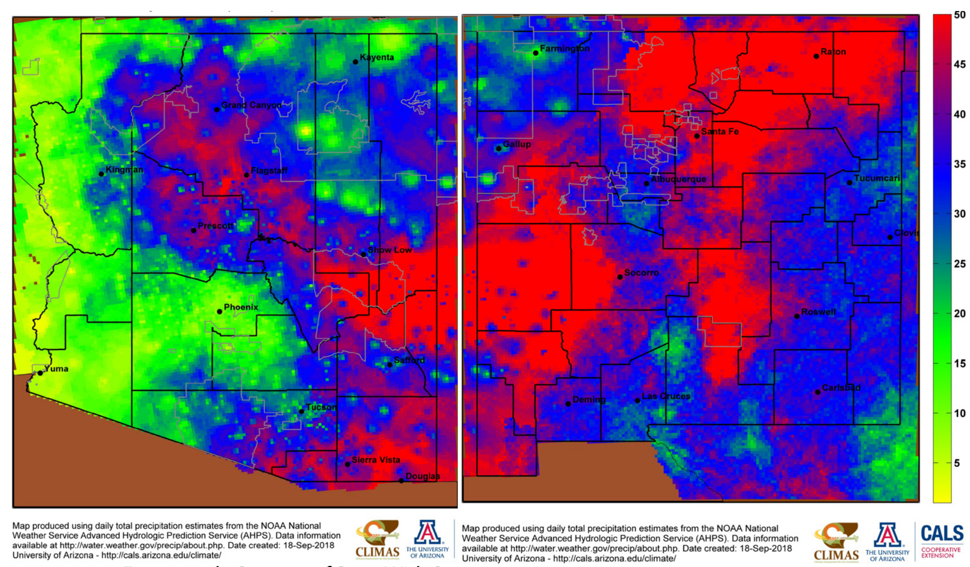


Figure 5a-b: Percent of Days With Precipitation (>0.01") - Jun 15 - Sep 17, 2018

Online Resources

Figures 6-7
CLIMAS: Climate Assessment for the Southwest
climas.arizona.edu

Data: NWS-Tucson, RainLog.org, & Pima County Flood Control District

A look at monsoon precipitation across the Tucson metropolitan area illustrates the spatial heterogeneity of monsoon events. Some areas receive frequent and/or abundant precipitation, while others–often nearby–do not (Figs. 6-7). Individual stations (e.g. the Tucson Airport) track long-term comparisons to normal at that single location, but cannot capture this variability. Higher elevation areas are expected to receive more precipitation, but the range found in lower elevation locations highlights how daily and cumulative totals can vary across a remarkably short distance.

CLIMAS has a new project in collaboration with the National Weather Service in Tucson exploring how to integrate citizen science rainfall observations into monsoon analysis and visualizations, and how to compare these observations to official stations and radar-derived estimates of precipitation. If you have any questions or want more information, contact Ben McMahan at bmcmahan@email.arizona.edu

RainLog: rainlog.org
CoCoRaHs: cocorahs.org

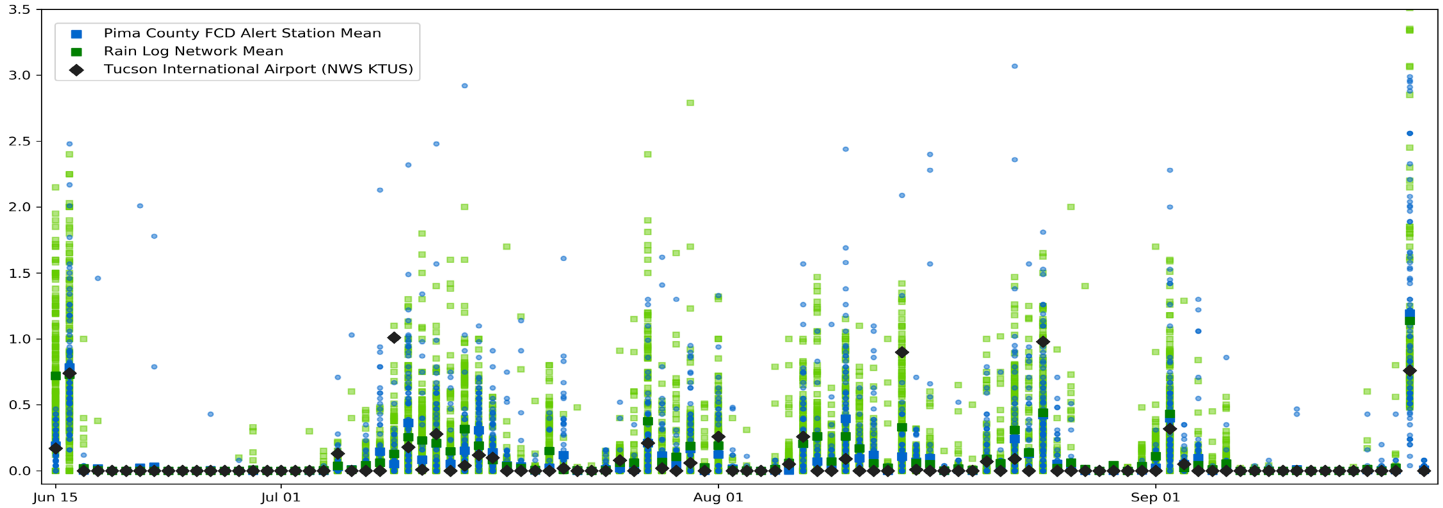


Figure 6: Monsoon Precipitation Jun 15 - Sept 20 (Pima County FCD, Rain Log, and Tucson Int. Aiport)

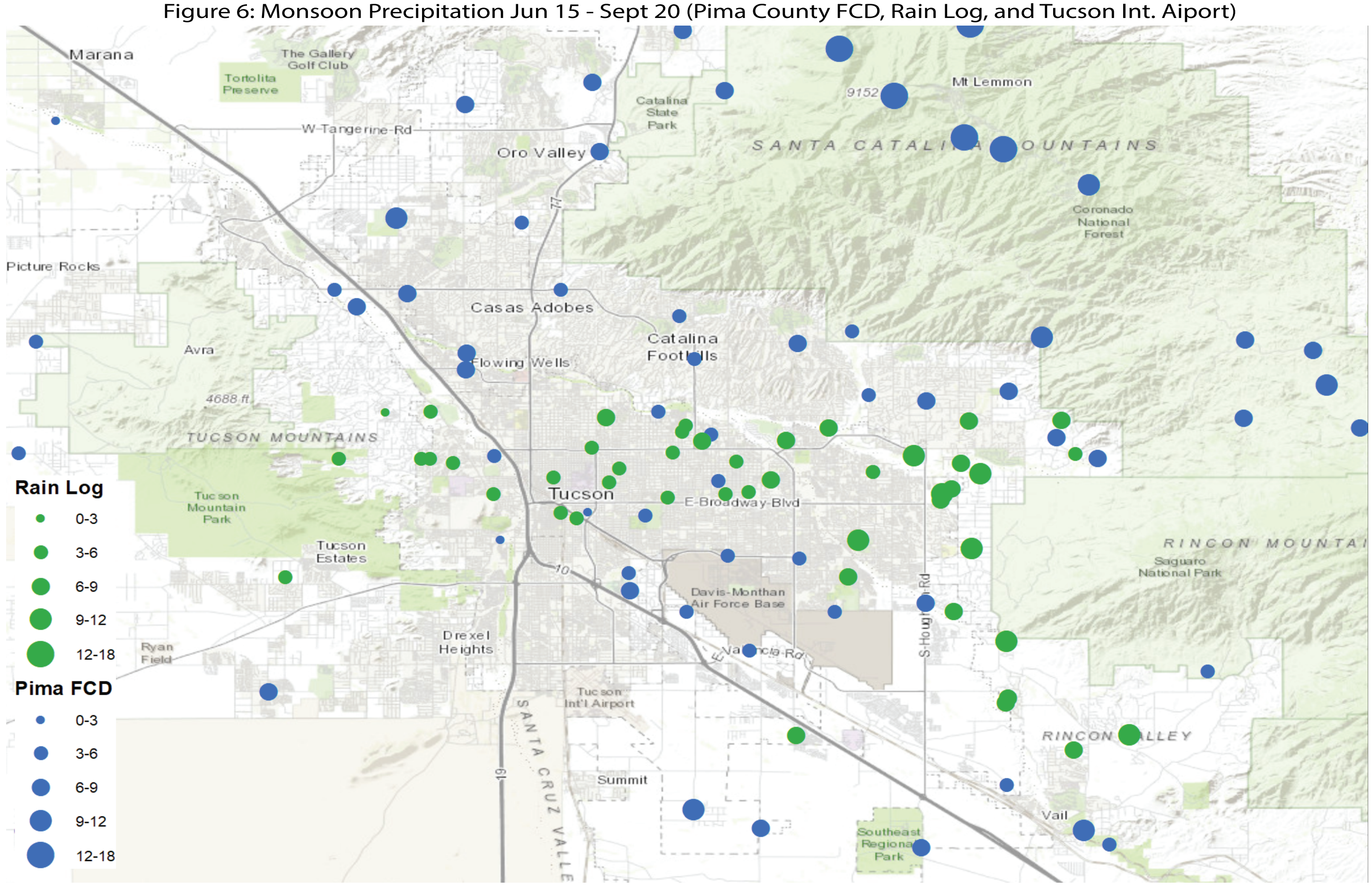


Figure 7: Cumulative Precipitation Jun 15 - Sept 20, 2018 (Rainlog & Pima FCD Networks)

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).

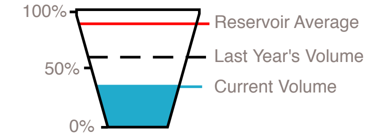
The table details more exactly the current capacity (listed as a percent of maximum storage). Current and maximum storage are given in thousands of acre-feet for each reservoir. One acre-foot is the volume of water sufficient to cover an acre of land to a depth of 1 foot (approximately 325,851 gallons).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

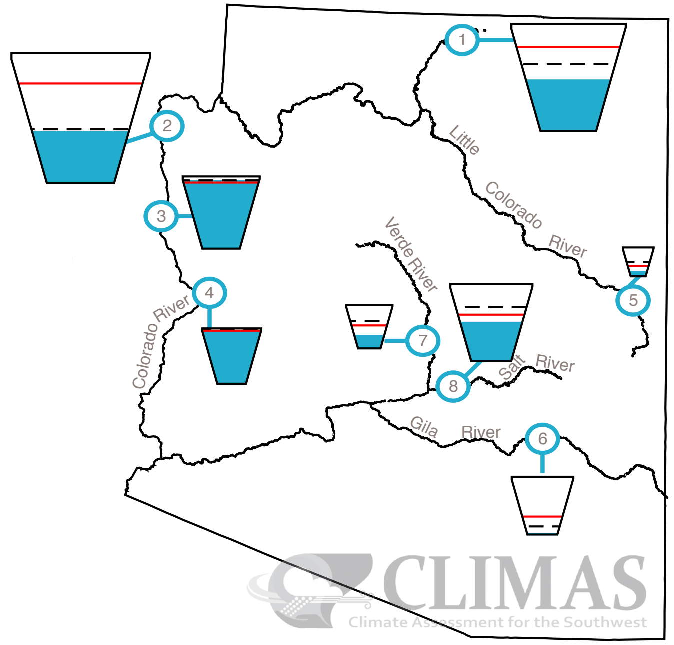
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS).

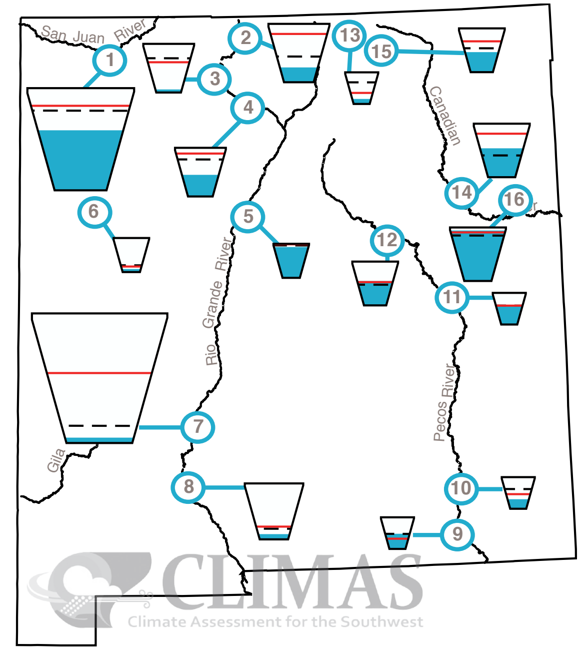
Reservoir Volumes

DATA THROUGH SEPT 1, 2018

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







* in KAF = thousands of acre-feet

Reservoir	Capacity	Current Storage*	Max Storage*	One-Month Change in Storage*
1. Lake Powell	47%	11,477.4	24,322.0	-639.0
2. Lake Mead	38%	9,918.0	26,159.0	119.0
3. Lake Mohave	93%	1,679.0	1,810.0	-24.0
4. Lake Havasu	93%	573.5	619.0	-8.4
5. Lyman	18%	5.3	30.0	-1.0
6. San Carlos	0%	2.6	875.0	2.2
7. Verde River System	30%	85.3	287.4	5.0
8. Salt River System	50%	1,019.4	2,025.8	-34.2

*KAF: thousands of acre-feet

Reservoir	Capacity	Current Storage*	Max Storage*	One-Month Change in Storage*
1. Navajo	58%	991.3	1,696.0	-88.8
2. Heron	25%	98.9	400.0	-34.3
3. El Vado	6%	10.9	190.3	3.0
4. Abiquiu	44%	81.9	186.8	-7.8
5. Cochiti	90%	45.1	50.0	-0.2
6. Bluewater	9%	3.5	38.5	-0.1
7. Elephant Butte	4%	85.4	2,195.0	-43.5
8. Caballo	9%	29.8	332.0	-6.6
9. Lake Avalon	47%	2.1	4.5	-0.5
10. Brantley	30%	12.7	42.2	-7.5
11. Sumner	61%	22.0	35.9	0.1
12. Santa Rosa	56%	59.6	105.9	0.9
13. Costilla	16%	2.6	16.0	-1.8
14. Conchas	54%	136.9	254.2	-10.4
15. Eagle Nest	45%	35.9	79.0	-1.1
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

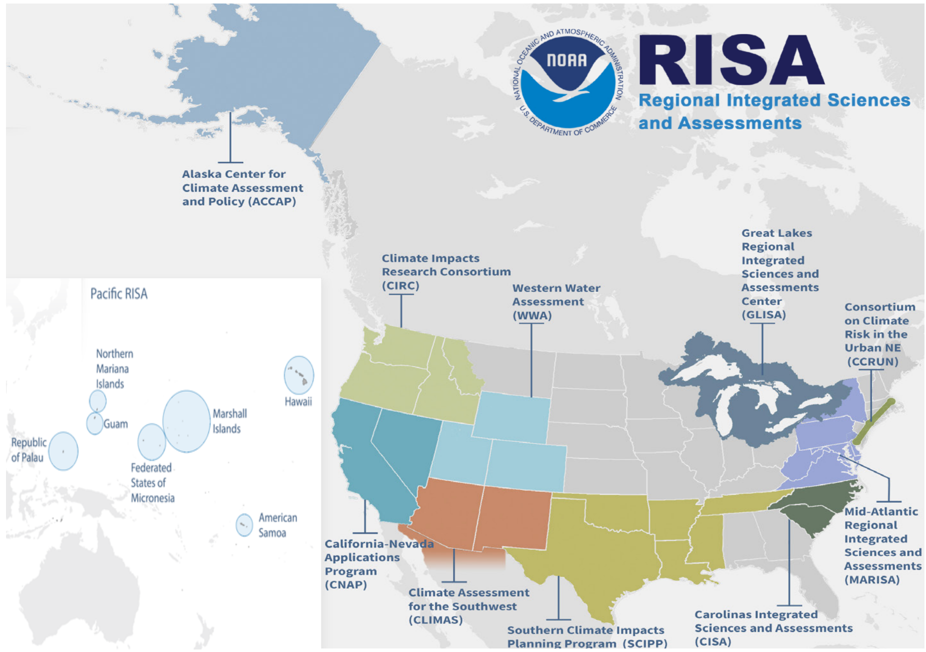
climas.arizona.edu/climate-services

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.



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.

August 2018 SW Climate Podcast

Monsoon Midpoint Review - The "Expectations and Potential vs. Reality" Edition

In the August edition of the Southwest Climate Podcast, Mike Crimmins and Zack Guido discuss the monsoon in the Southwest this year. They focus on how it compares to past events and long-term averages, and discuss the spatial and temporal variability of the storms that occur during the monsoon (i.e. did it rain at your house or not?). As part of their regional roundup, they talk about why (really, how) Phoenix has been hogging more monsoon events than usual, and make note of the untapped potential in other parts of the Southwest, where conditions have been ripe for widespread monsoon activity, but have not seen the kind of "epic" monsoon that Zack (and much of central Tucson) was hoping for. Mike reminds us that over the longer term it eventually evens out, although this is limited comfort for those who are on the losing (dry) end of the range of monsoon precipitation to date.

https://bit.ly/2BBdvCu