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October Southwest Climate Outlook

Monthly Precipitation and Temperature: September precipitation in Arizona ranged from much below average in the north, to much above average in the south, while most of New Mexico was average to below average (Fig. 1a). September temperatures were mostly average to much above average in Arizona and mostly much above average to record warmest in New Mexico (Fig. 1b). The daily average temperature anomalies for Sept 1 – Oct 15 (Fig. 2) highlight the fluctuations at select stations around the region.

Annual Precipitation and Temperature: Total precipitation for 2019 (Jan-Sept) in Arizona was mostly average to above average, with some below average in the four corners region, while New Mexico was drier with average to below average across most of the state, along with some pockets of much below average conditions (Fig. 3a). Mean temperatures in 2019 so far are mostly above average in Arizona and above average to much above average in New Mexico (Fig. 3b).

Drought: Water year precipitation (Oct 1 2018 – Sept 30 2019) was mostly normal to above normal across most of Arizona and much of northeastern New Mexico, while parts of eastern Arizona and south-central and northwestern New Mexico were normal to below normal (Fig. 4). These totals are buoyed by tropical storm activity in Oct 2018 and Sept 2019, and may be skewing some characterizations of longer term precipitation. Given recent conditions and the below average monsoon, drought has returned to much of Arizona and western New Mexico in the Oct 8 U.S. Drought Monitor (USDM) (Fig. 5). This designation is leaning more heavily on recent below average monsoon precipitation, despite water year precipitation totals.

Tropical Storm Activity: The eastern North Pacific hurricane season has been near normal, with 16 named storms as of Oct. 16 (Fig. 6), including four major hurricanes (category 4 or above), with the average through this date at approximately 15 named storms and 4 major hurricanes. The Accumulated Cyclonic Energy (ACE) to date is 95 (for comparison, last year this time ACE was 295), while the average to date is approximately 120. Recent notable events include heavy precipitation linked to TS Lorena and TS Mario, which funneled moisture into a cutoff low in mid-to-late September. This brought highly variable but at times intense storms to southern Arizona, including some supercell formation in central and eastern Arizona. Given the meager monsoon, their impacts are visible on the percent of normal maps (see Monsoon Tracker on pp. 4-6).

ENSO Tracker: Oceanic and atmospheric conditions are generally consistent with an ENSO-neutral outlook for 2019 and into 2020 (see ENSO-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 much of Arizona, New Mexico, and northwestern Mexico (Fig. 7, top). The three-month temperature outlook calls for increased chances of above-normal temperatures across the U.S. Southwest and northern Mexico (Fig. 7, bottom).

Tweet Oct 2019 SW Climate Outlook

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OCT2019 @CLIMAS_UA SW Climate Outlook, Monsoon Recap, ENSO Tracker, AZ & NM Reservoir volumes, bit.ly/33IkAKJ #SWclimate #AZWX #NMWX

October 2019 SW Climate Outlook

Online Resources

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

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

Figure 4
Western Regional Climate Center
wrcc.dri.edu

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

Figure 6
NWS Eastern North Pacific Hurricane Tracker
nhc.noaa.gov

Figure 7
Intl. Research Institute for Climate and Society
iri.columbia.edu

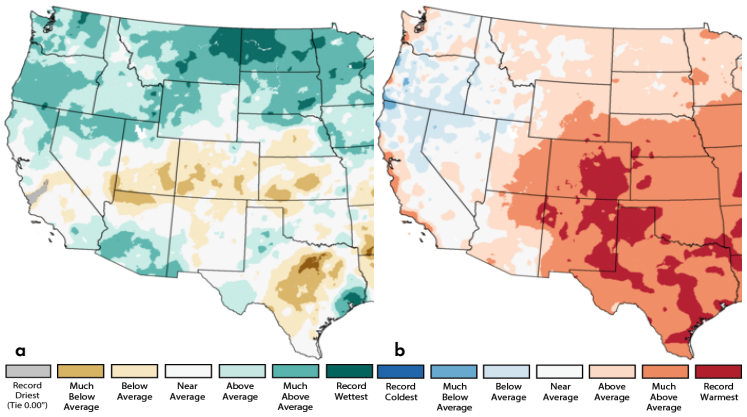


Figure 1: Sept 2019 Precipitation (a) & Temperature Ranks (b)

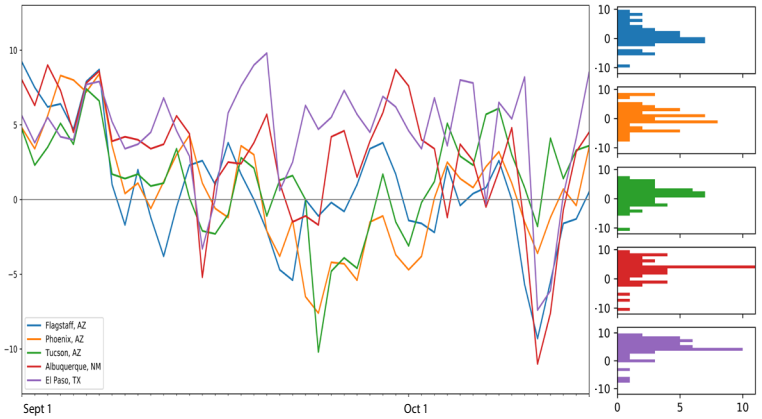


Figure 2: Daily Temperature Anomalies Sept 1- Oct 15 (L) & Frequency of Anomalies (R)

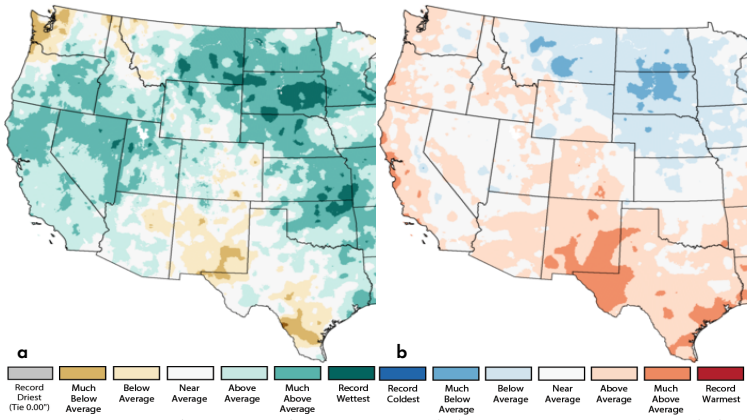


Figure 3: 2019 (Jan - Sept) Precipitation (a) & Temperature Ranks (b)

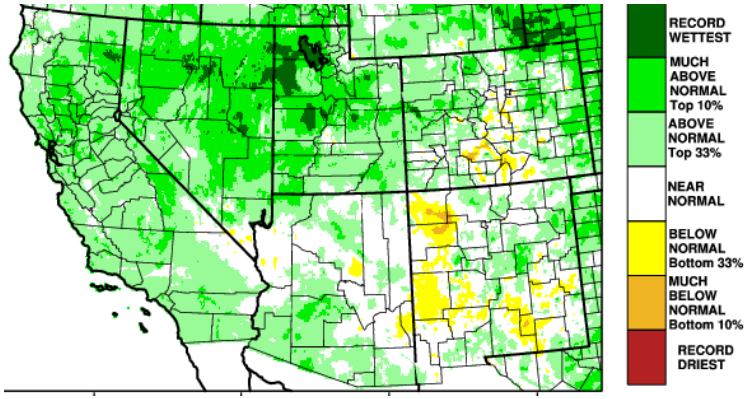


Figure 4: Oct 2018 - Sept 2019 - Water Year Precipitation Percentile Rank

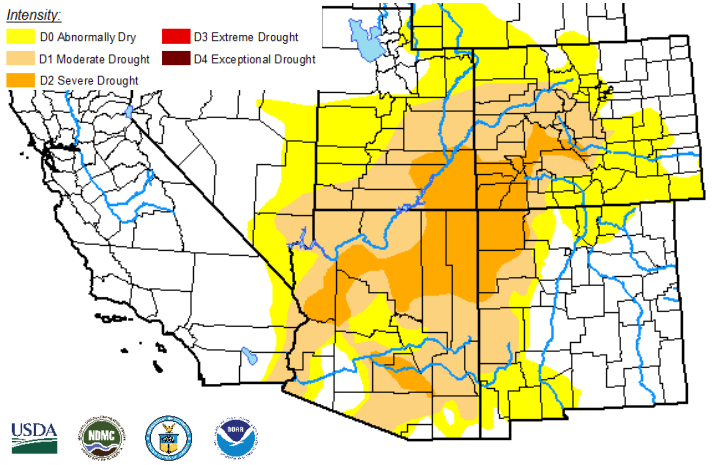


Figure 5: US Drought Monitor - Oct 8, 2019

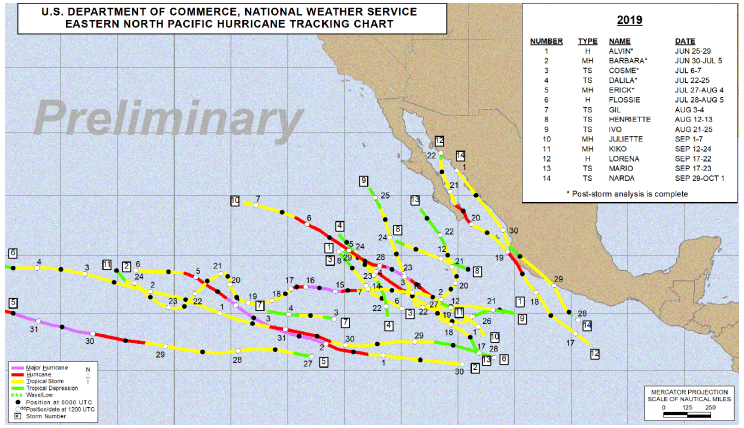


Figure 6: National Weather Service Eastern North Pacific Tracking Chart

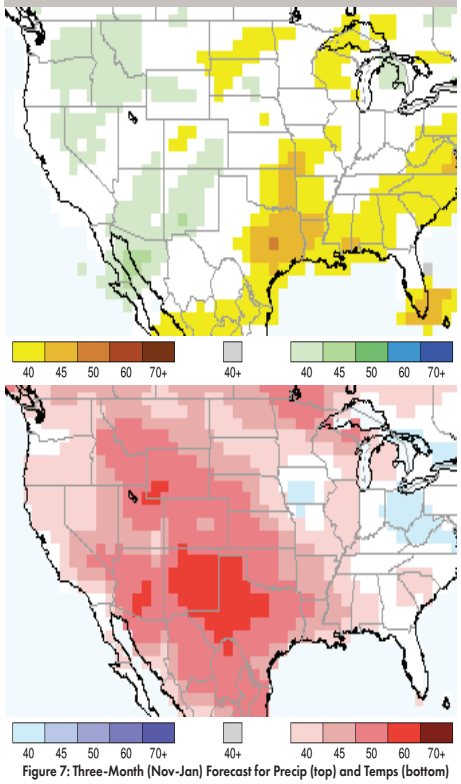


Figure 7: Three-Month (Nov-Jan) Forecast for Precip (top) and Temps (bottom)

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

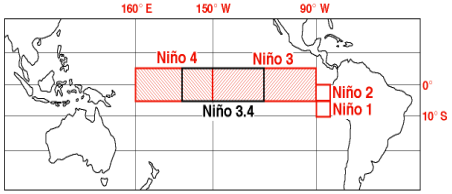
Figure 4
NOAA - Climate Prediction Center
cpc.ncep.noaa.gov

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

Forecast Roundup: Despite warmer waters in the equatorial Pacific, seasonal outlooks and forecasts based on sea surface temperature (SST) anomalies (Figs. 1-2) and other oceanic and atmospheric indicators, all point to ENSO-neutral conditions lasting through 2019 and into 2020. On Oct 10, the Japanese Meteorological Agency (JMA) highlighted lingering warmer-than-normal SSTs in the western equatorial Pacific, and maintained their call for a 60-percent chance of ENSO-neutral conditions to continue until winter 2019-2020. On Oct 10, the NOAA Climate Prediction Center (CPC) issued their ENSO diagnostic discussion with an inactive alert status, and focused on neutral conditions across the oceans and atmosphere. They called for an 85-percent chance of ENSO-neutral conditions persisting through fall 2019, and a 55- to 60-percent chance of ENSO-neutral through spring 2020. On Oct 10, the International Research Institute (IRI) issued an ENSO Quick Look (Fig. 3), emphasizing neutral conditions in oceanic and atmospheric indicators. Their models see ENSO-neutral as the most likely outcome, but remain at "slightly higher chances for El Niño than La Niña". On Oct 15, the Australian Bureau of Meteorology maintained their ENSO Outlook at 'inactive' with most oceanic and atmospheric conditions in the range of neutral. The Oct 2019 North American Multi-Model Ensemble (NMME) saw a turn back towards positive SST anomalies, but is forecast to remain within the range of ENSO-neutral through 2019 (Fig. 4).

Summary: ENSO-neutral remains the most likely outcome for 2019 into spring 2020, with oceanic and atmospheric conditions within the range of ENSO-neutral. Seasonal outlooks had been calling for increased chances of above average precipitation and temperatures for late fall and into winter. We originally assumed this was linked to the increased chance of enhanced tropical storm activity in the eastern pacific associated with El Niño, but with a return to ENSO-neutral, El Niño is not a factor. Warmer and (mostly) wetter than normal conditions remain in the seasonal outlooks however (see Fig. 7 on p. 2), although the reason is not entirely clear. November is climatologically relatively dry in the Southwest, so it does not take much precipitation to go above normal, and it may be late season tropical storm activity that is tilting this forecast wet. Tropical storm activity so far has hovered just below average in the eastern Pacific, and in September TS Lorena and TS Mario ushered moisture into the Southwest and interacted with a cutoff low to boost precipitation in southern Arizona (including supercell activity), after a mostly below average monsoon (see Monsoon Tracker on p. 4-6 for details).

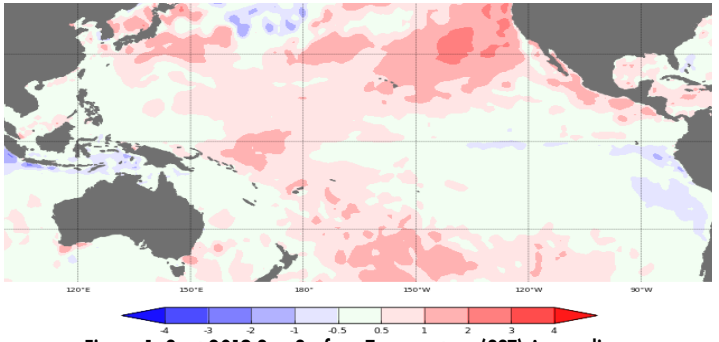


Figure 1: Sept 2019 Sea Surface Temperature (SST) Anomalies

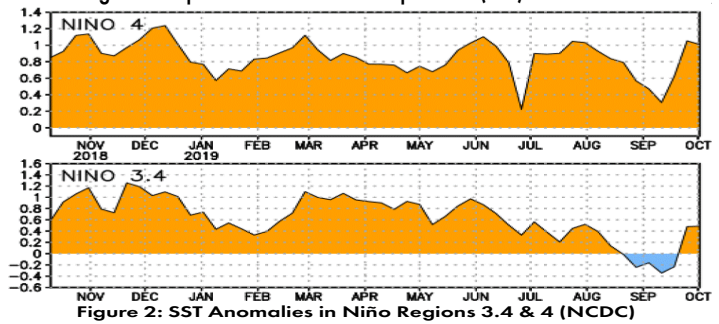


Figure 2: SST Anomalies in Niño Regions 3.4 & 4 (NCDC)

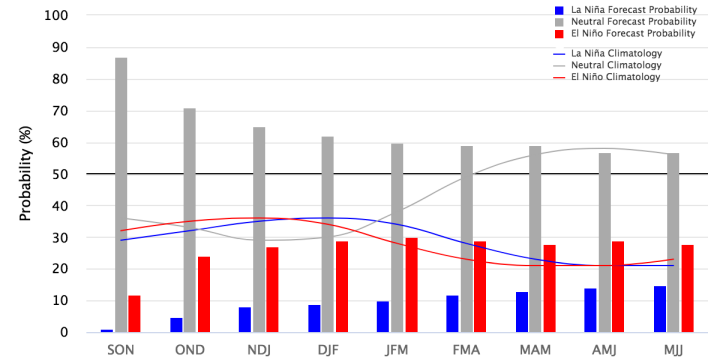


Figure 3: Early-Oct IRI/CPC Model-Based Probabilistic ENSO Forecast

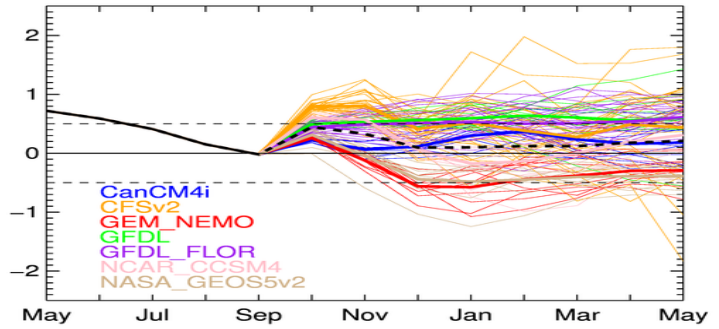


Figure 4: North American Multi-Model Ensemble Forecast for Niño 3.4

Online Resources

Figures 1-2
Climate Assessment for the Southwest
climas.arizona.edu

Southwest Climate Podcast

Oct 2019 - The 'Conservation of Misery and Lapse Rate Doping' Edition

In the Oct 2019 edition of the CLIMAS Southwest Climate Podcast, Mike Crimmins and Zack Guido recap the monsoon that was - or in many places, wasn't. They discuss the monsoon overall (from June 15 - Sept 30), as well as recent September precipitation related to tropical storm activity and cut-off lows, to play the annual "is this monsoon or not?" game. They also think through how these events can juice seasonal totals, and take a closer look at the climatology of events (i.e. tropical storms) that supplement precipitation totals during the June 15 - Sept 30 monsoon period, and they consider how seasonal statistics might play out if we used a more restrictive definition for monsoon days and associated rainfall totals.
climas.arizona.edu/media/podcasts

Monsoon Recap

Single weather stations around the region are useful for comparing long term averages to the current year. Figure 1 summarizes monthly precipitation, and shows 2019 lagged behind 2018 and long term averages in most months at most locations. Plots of daily precipitation for stations around the region (Fig. 2) illustrate the slow start and lower than average totals across the region.

This monsoon was notable in how much it deviated from the past few years, where many locations in the Southwest saw a run of above normal monsoon precipitation. This made 2019 particularly disappointing. A look at the long term averages demonstrates that 2019 is consistent with some of the drier monsoons on record, even while specific station locations were at or near record driest.

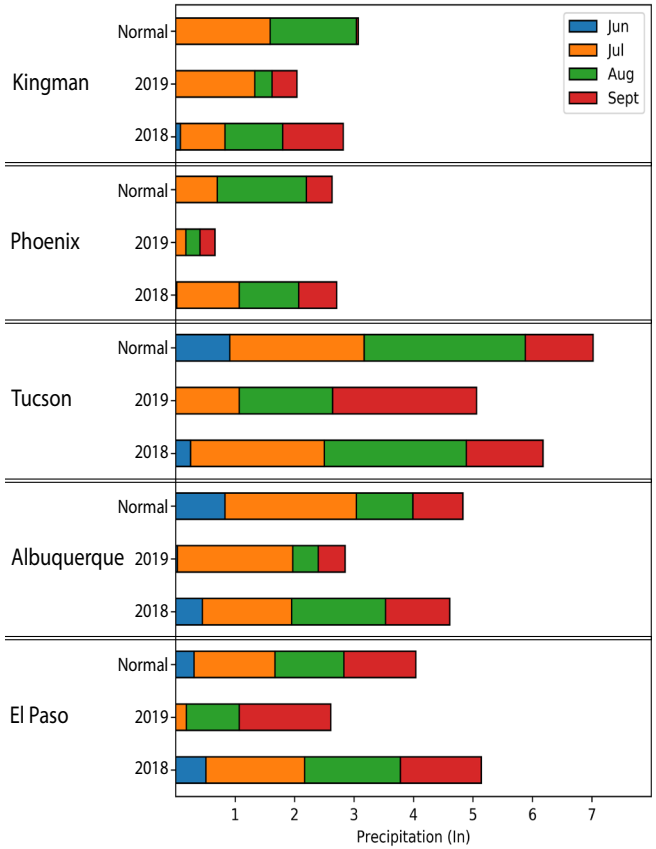


Figure 1: Monthly Monsoon Precipitation Totals - 2018, 2019 & Average

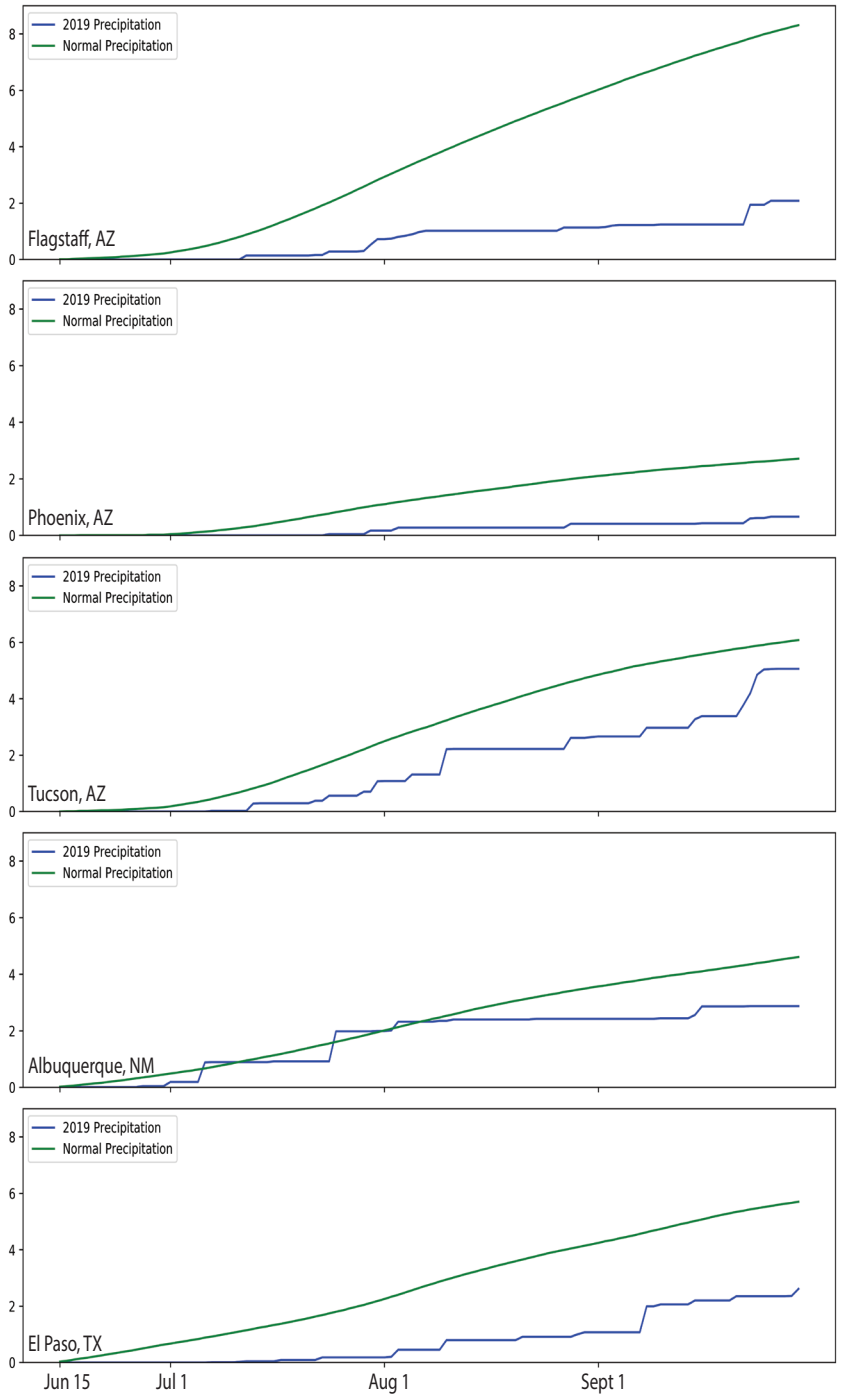


Figure 2: 2019 vs. Average - Cumulative Monsoon Precipitation Jun 15 - Sept 30

Online Resources

Figures 3-5
Climate Science Applications Program
cals.arizona.edu/climate/misc/SWMonsoonMaps/current/swus_monsoon.html

Contact Mike Crimmins with questions and/or suggestions on how to improve these plots, or ideas for additional variables

* The Southwest U.S. Monsoon Technical Summaries contain a wealth of information about different locations across the Southwest, including current vs. average accumulated precipitation, seasonal midpoints, and analog years. cals.arizona.edu/climate/misc/monsoon/monsoon_summaries.html

Monsoon Recap (cont.)

Total monsoon precipitation (Fig. 3) varied across the Southwest, with much of the region recording below normal precipitation (Fig. 4), especially in northern Arizona and the four corners. Percent of days with rain (Fig. 5) highlights the regularity of rainfall events, or lack thereof. This was one of the drier monsoons of recent memory, but is consistent with the range of totals in the long term averages. Tropical storms interacting with a cutoff low triggered intense storms in September (Figs. 6-7 on p. 6), and storm locations and tracks are visible on Fig. 4 between Yuma and Phoenix, having boosted otherwise dry conditions.

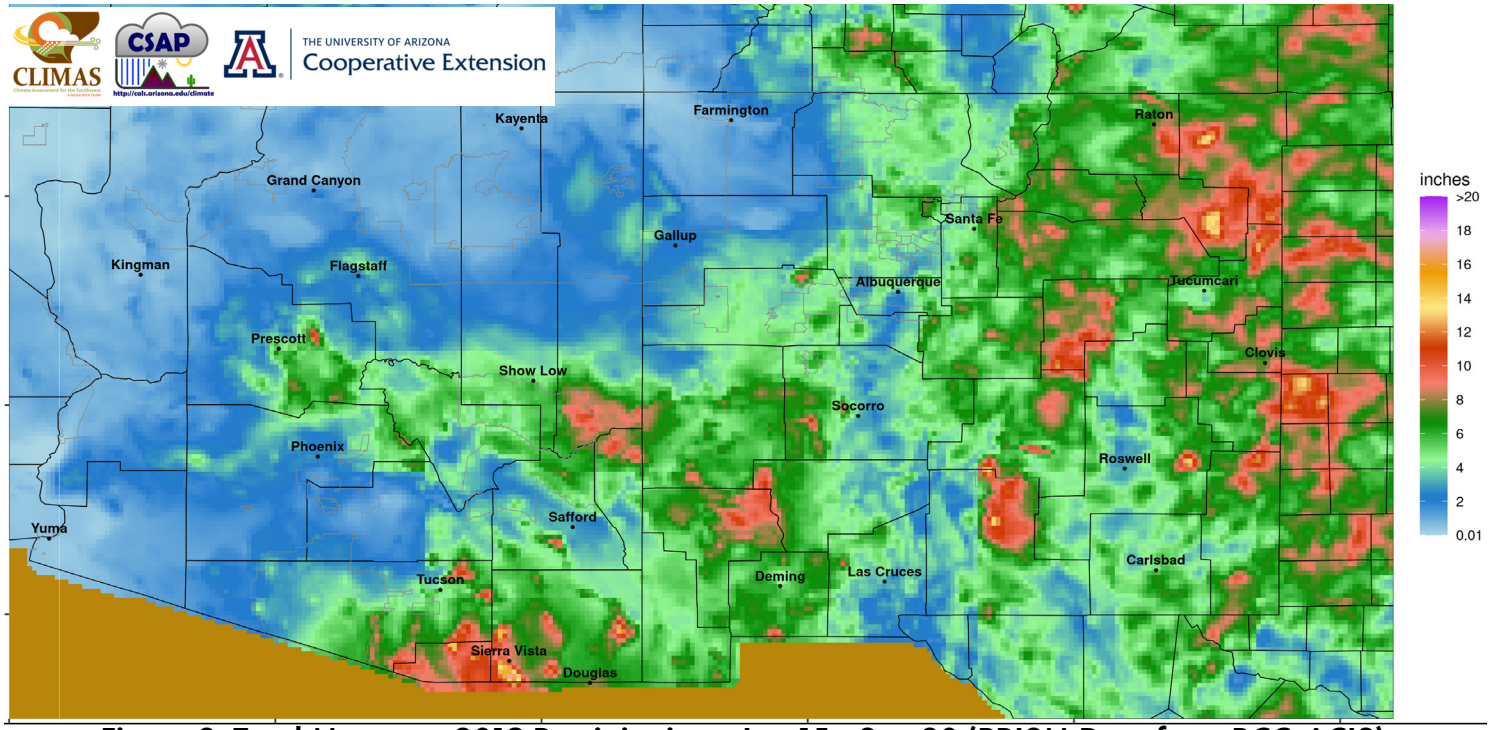


Figure 3: Total Monsoon 2019 Precipitation - Jun 15 - Sep 30 (PRISM Data from RCC-ACIS)

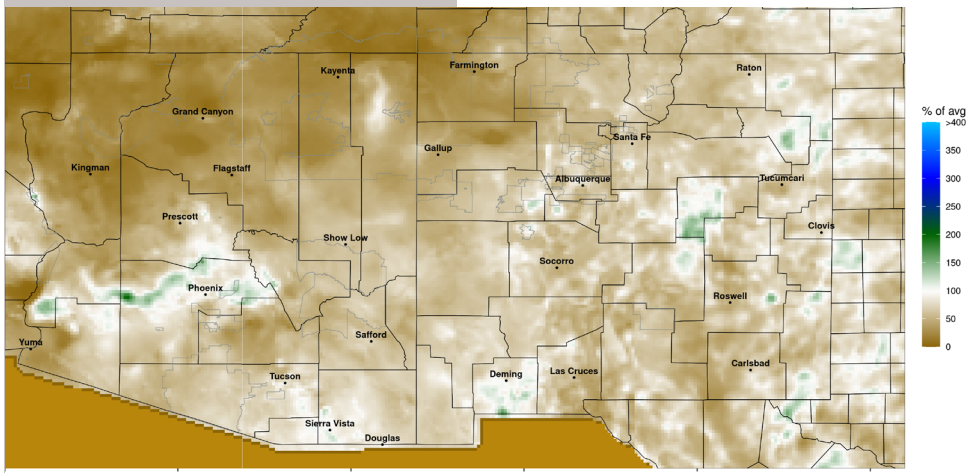


Figure 4: Monsoon 2019 Precipitation Percent of Average - Jun 15 - Sept 30 (PRISM Data / RCC-ACIS)

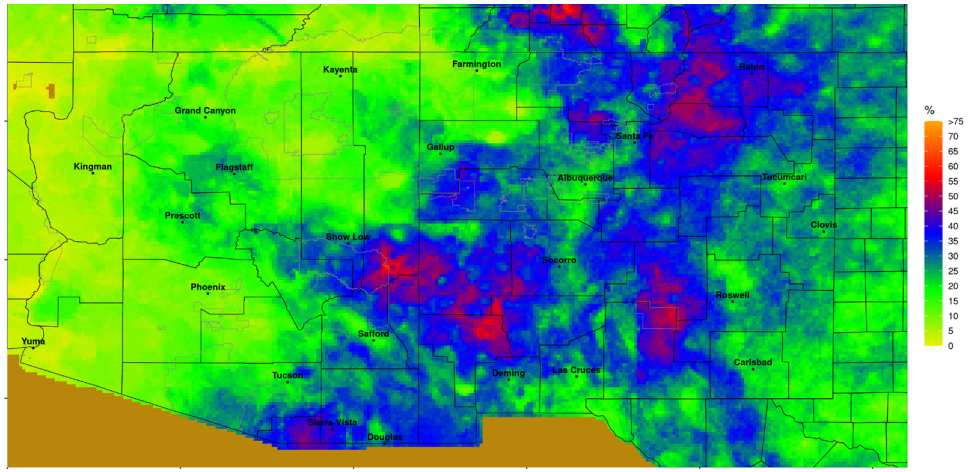


Figure 5: Monsoon 2019 Percent of Days With Rain - Jun 15 - Sept 30 (PRISM Data from RCC-ACIS)

Online Resources

Figures 6-7
Climate Science Applications Program
cals.arizona.edu/climate/misc/SWMonsoonMaps/current/swus_monsoon.html

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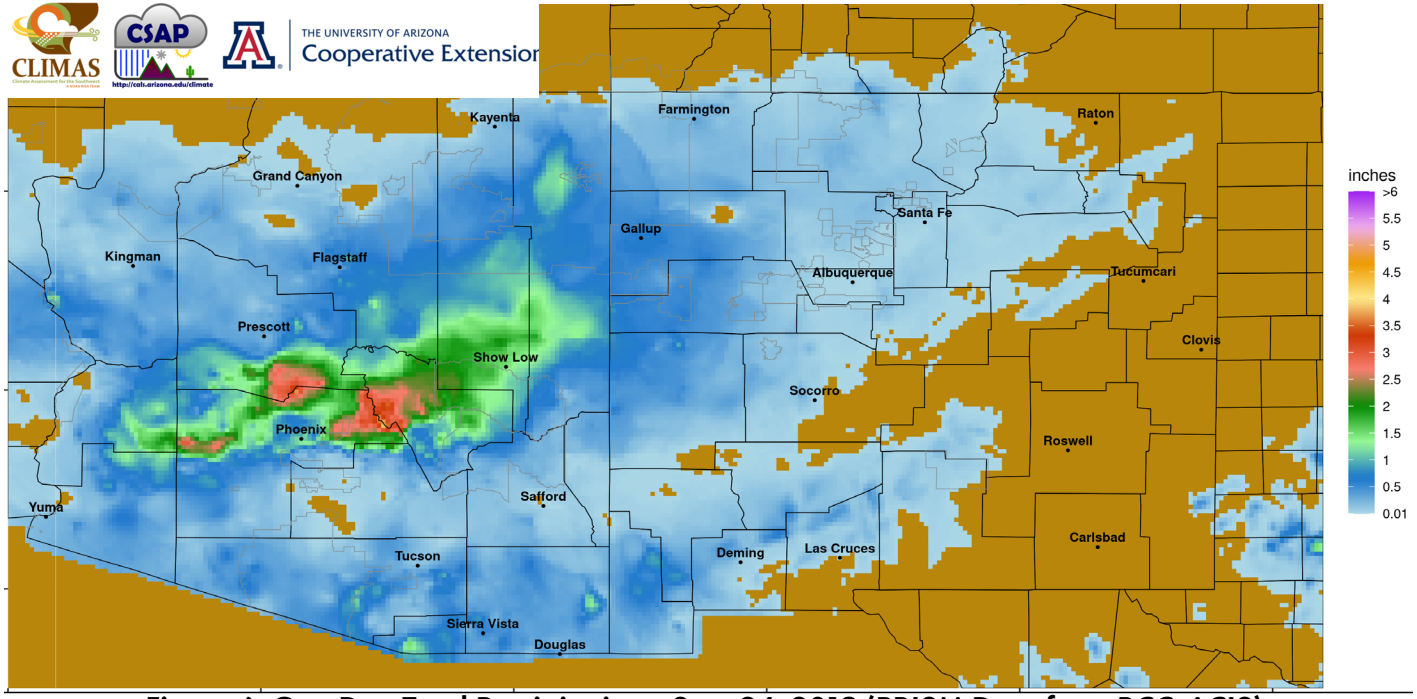


Figure 6: One Day Total Precipitation - Sept 24, 2019 (PRISM Data from RCC-ACIS)

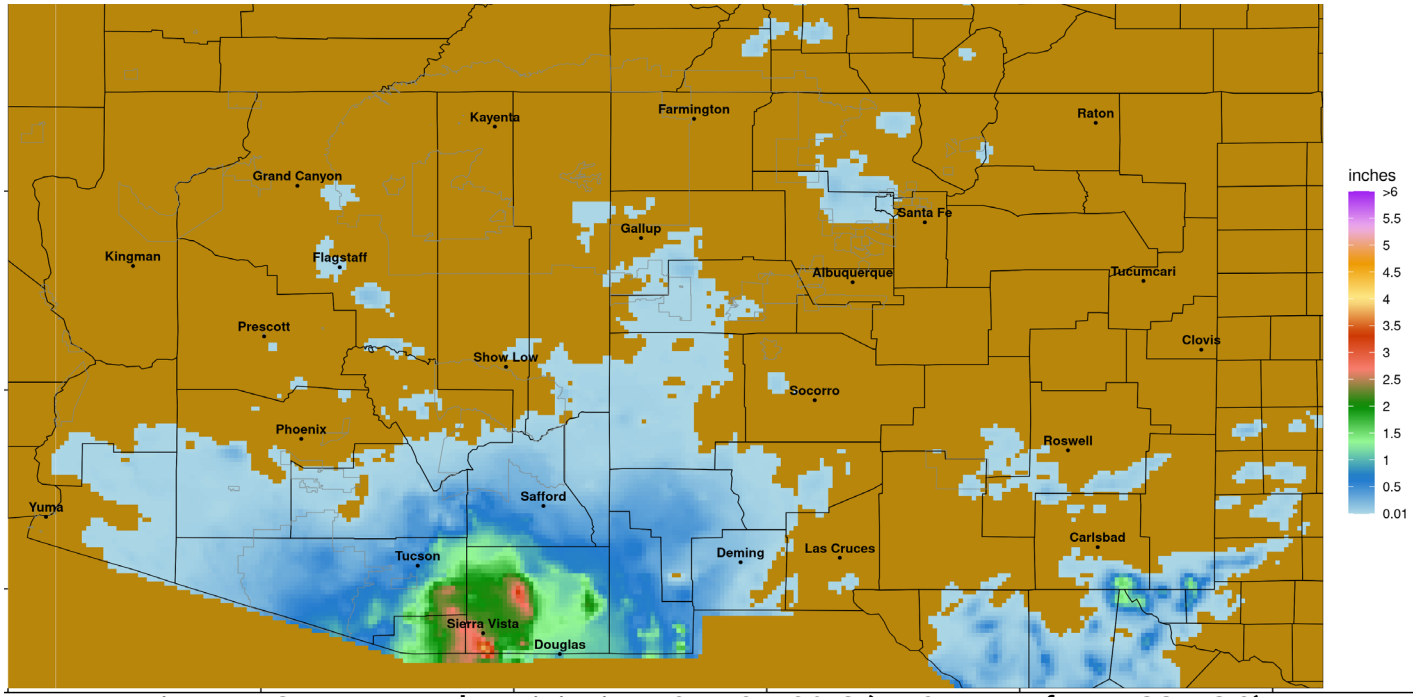


Figure 7: One Day Total Precipitation - Sept 25, 2019 (PRISM Data from RCC-ACIS)

Online Resources

Portions of the information provided in this figure is available at the Natural Resources Conservation Service
www.wcc.nrcs.usda.gov/BOR/basin.html

Contact Ben McMahan with questions/comments.

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).

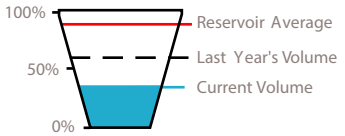
The table details more exactly the current capacity (listed as a percent of maximum storage). Current and maximum storage are given in thousands of acre-feet for each reservoir. One acre-foot is the volume of water sufficient to cover an acre of land to a depth of 1 foot (approximately 325,851 gallons).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

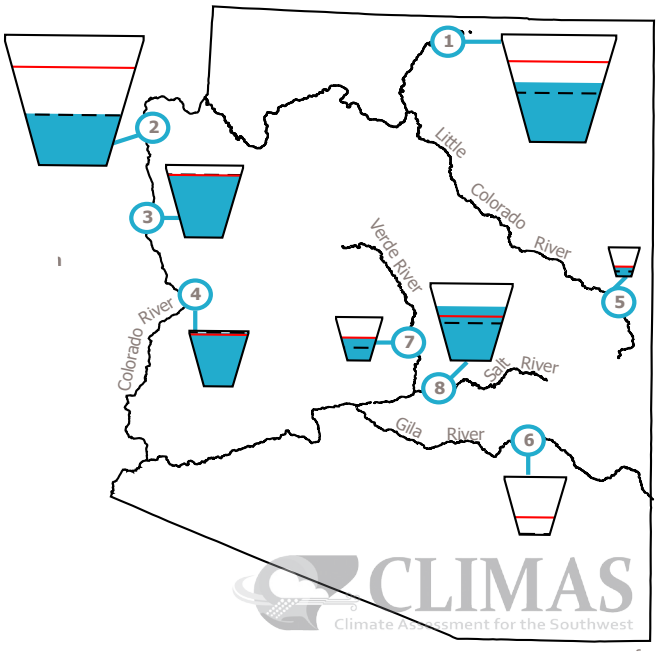
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS).

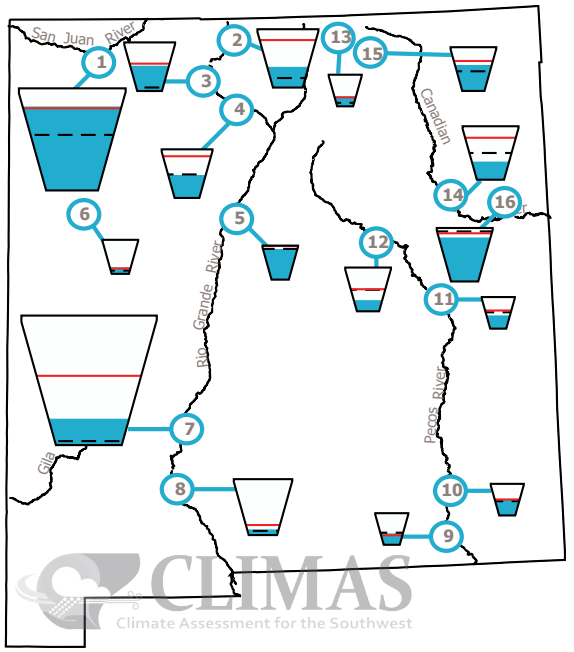
Reservoir Volumes

DATA THROUGH OCT 1, 2019

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	55%	13,277.4	24,322.0	-332.8
2. Lake Mead	39%	10,267.0	26,159.0	-37.0
3. Lake Mohave	87%	1,576.0	1,810.0	-102.0
4. Lake Havasu	97%	602.6	619.0	34.7
5. Lyman	34%	10.1	30.0	-1.4
6. San Carlos	1%	11.0	875.0	-16.9
7. Verde River System	54%	155.7	287.4	-0.6
8. Salt River System	70%	1,421.3	2,025.8	-33.3

*KAF: thousands of acre-feet

Reservoir	Capacity	Current Storage*	Max Storage*	One-Month Change in Storage*
1. Navajo	82%	1388.1	1,696.0	-70.4
2. Heron	35%	138.9	400.0	-29.8
3. El Vado	52%	99.4	190.3	-9.1
4. Abiquiu	47%	87.1	186.8	15.2
5. Cochiti	90%	45.1	50.0	-0.5
6. Bluewater	19%	7.2	38.5	-0.8
7. Elephant Butte	20%	428.3	2,195.0	-30.6
8. Caballo	10%	32.6	332.0	-15.0
9. Lake Avalon	36%	1.6	4.5	-0.2
10. Brantley	52%	21.8	42.2	3.9
11. Sumner	42%	14.9	35.9	-2.9
12. Santa Rosa	25%	26.4	105.9	-20.9
13. Costilla	31%	5.0	16.0	-2.2
14. Conchas	33%	83.2	254.2	-11.6
15. Eagle Nest	59%	46.9	79.0	0
16. Ute Reservoir	82%	164	200	-7.0

Online Resources

Figure 1
Climate Program Office
cpo.noaa.gov

RISA Program Homepage

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

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

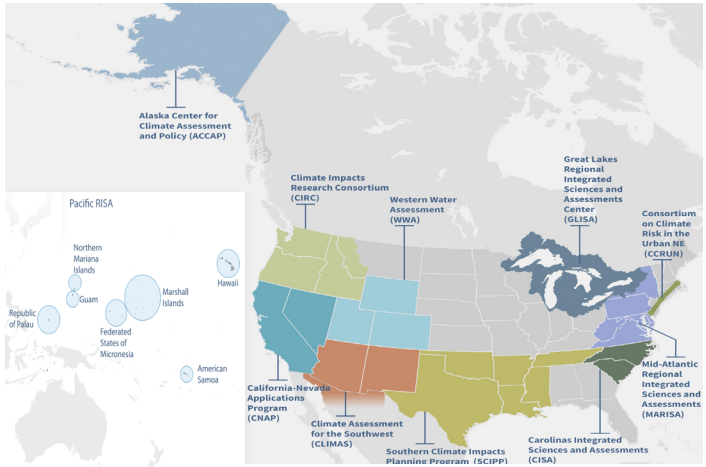


Figure 1: NOAA Regional Integrated Sciences and Assessments Regions

What does CLIMAS do?

The CLIMAS team and 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.

2020 CLIMAS Environment & Society Graduate Fellows

Applications Due: Thursday, October 17, 2019

The Climate Assessment for the Southwest (CLIMAS) program is currently accepting applications for the 2020 Environment & Society Graduate Fellows Program. This fellowship supports 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 for projects occurring between January–December 2020. The Environment & Society Fellows Program is made possible by the University of Arizona Office of Research, Development, & Innovation and CLIMAS.

The Environment & Society Fellowship provides an opportunity for graduate students to develop their knowledge, training, and experience in applied environmental science and outreach. Projects should incorporate a use-inspired research approach meaning that the project meets a need expressed by a stakeholder (an organization, community, or person affected by your research outcomes). Competitive proposals will include a component of stakeholder engagement or collaboration. Projects can fall under one or more of the following categories: scoping research, dissertation/thesis work, a discrete 1-year project, outreach, and/or network building.

For more information and to apply:

climas.arizona.edu/content/environment-society-graduate-fellows-program