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October 2021 Southwest Climate Outlook

Precipitation and Temperature: Sept precipitation was between below average and above average in Arizona and New Mexico with much of the above average precipitation found in central and southern Arizona and far western New Mexico (Fig. 1a). Sept temperatures were average to record warm in Arizona and New Mexico (Fig. 1b). Jul-Sept precipitation ranks were average to record wet in Arizona and between much below and much above average in New Mexico (Fig. 2a). Jul-Sept temperature ranks were above average to much above average across the Southwest (Fig. 2b). Annual precipitation totals skew wet in areas with increased monsoon totals (i.e. central and southern Arizona and parts of southern New Mexico), while most of the rest of the southwest was average to much below average for precipitation, and above average to much above average for temperature (Fig 3a-3b).

Drought: Total water year precipitation (Oct 1 – Sept 30) is between much below normal and above normal across most of Arizona and New Mexico, with much below normal and record driest more prevalent in much of the rest of the Southwest (Fig. 4). Extending a trend from last month, the U.S. Drought Monitor (USDM) scaled back drought categorizations in New Mexico and Arizona, albeit to a lesser degree than last month (Fig. 5). This was in response to the wetter than average monsoon in parts of the Southwest. These summer storms brought some short-term relief, but long term and cumulative precipitation deficits remain a concern. Additionally, the USDM expanded drought characterizations in much of Colorado. This is something to watch given possible implications for water storage in reservoirs, snowpack, and soil moisture.

Water Supply: Most of the reservoirs are at or below the values recorded at this time last year. Most are also below their long-term average (see Arizona and New Mexico reservoir storage on p. 8).

Monsoon Recap: Monsoon activity was widespread and persistent from July through mid/late August, but tapered in September, save for a last minute transition event that rolled through on Sept 30. The timing and progression of this season's monsoon activity were relatively typical, but the seasonal totals were much higher than average especially in southern/central Arizona and parts of southern New Mexico (Fig. 6; p.5-7 for more maps and information). 2021 did not quite break any monsoon records, but it came close in a few places. Regardless of the records, the sustained and widespread rainfall was an especially welcome pivot from 2020's failed monsoon.

ENSO Tracker: ENSO has shifted to La Niña according to some outlooks (NOAA CPC, in particular), owing to observed and forecast SSTs, and emergent atmospheric conditions. Others forecast an onset of La Nina soon and lasting through winter 2021-2022 (see ENSO-tracker on p.4 for details).

Tweet Oct 2021 SW Climate Outlook

OCT2021 @CLIMAS_UA SW Climate Outlook, Seasonal Forecasts, Monsoon Recap, AZ & NM Reservoirs, SW Climate Podcast, https://bit.ly/3E3b330 #SWclimate #AZWx #NMWx

October 2021 - Climate Summary

Online Resources

Figures 1-3
National Centers for Environmental Information
ncdc.noaa.gov/sotc

Figure 4
West Wide Drought Tracker
wwdt.dri.edu

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

Figure 6
UA Climate Science Applications Program
cals.arizona.edu/climate

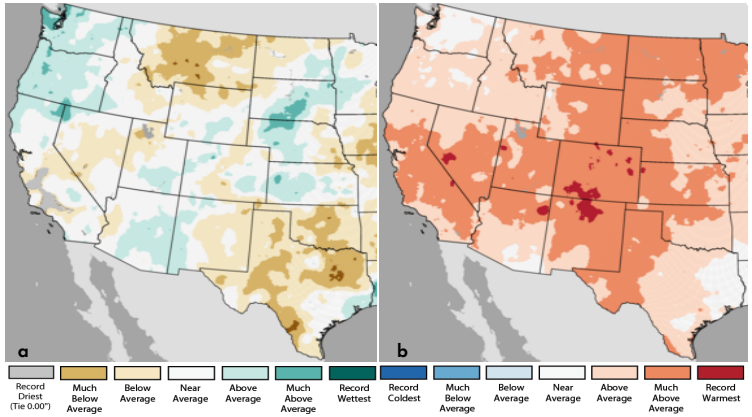


Figure 1: Sept 2021 Precipitation (a) & Temperature Ranks (b)

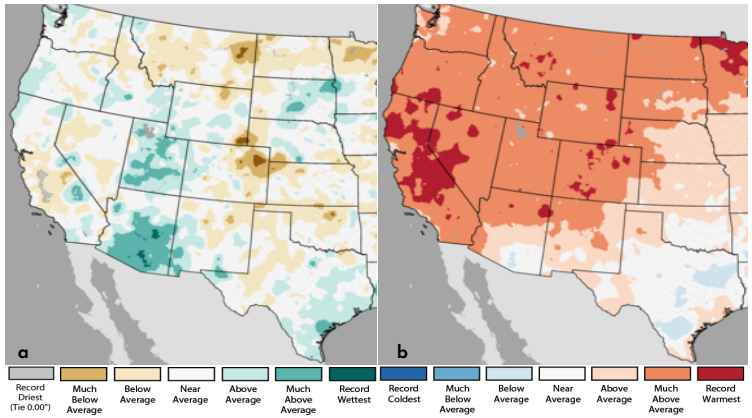


Figure 2: Jul-Sept 2021 Precipitation (a) & Temperature Ranks (b)

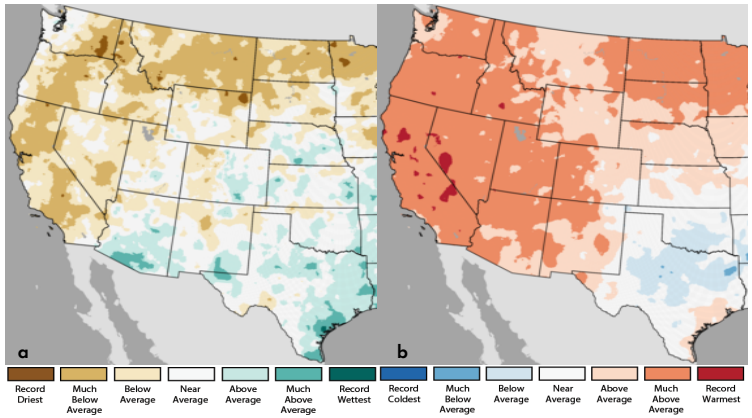


Figure 3: Jan-Sept 2021 Precipitation (a) & Temperature Ranks (b)

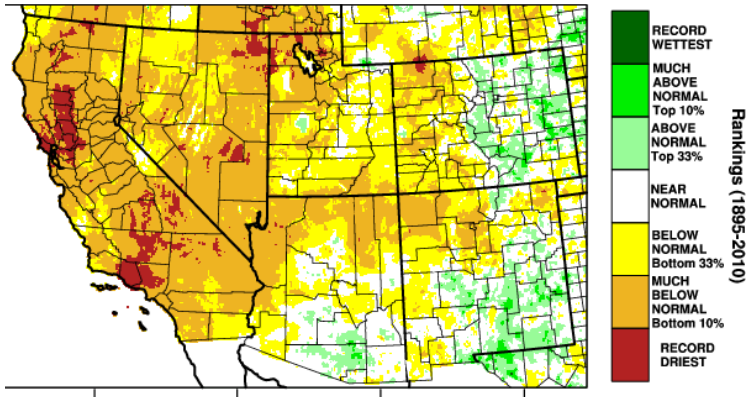


Figure 4: Water Year (Oct 2020 - Sept 2021) Precip Rankings

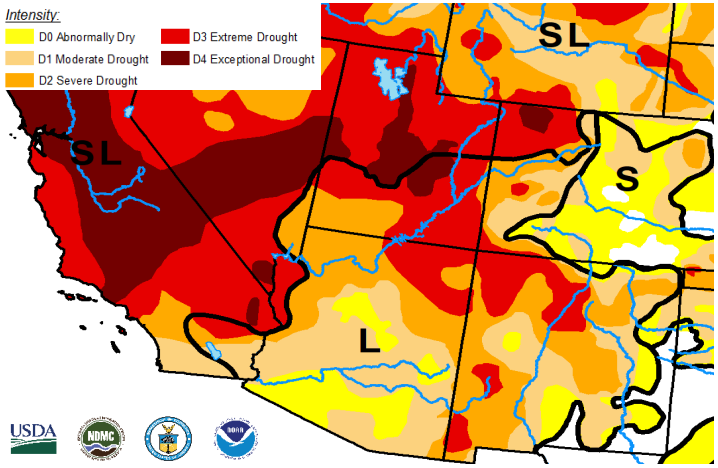


Figure 5: US Drought Monitor - Oct 5, 2021

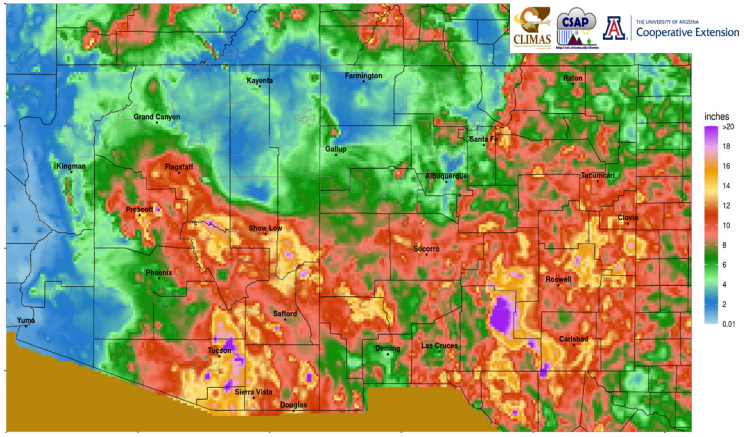


Figure 6: Total Precipitation, Jun 15 - Sept 30, 2021 (PRISM Data)

Online Resources

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

Figure 8
NOAA Climate Prediction Center
cpc.ncep.noaa.gov

October 2021 - Seasonal Forecasts

Precipitation

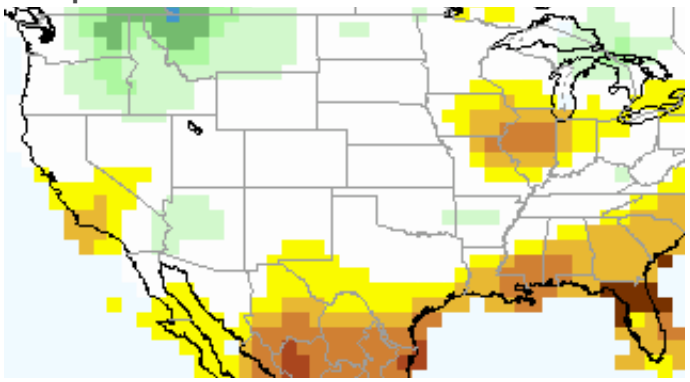


Figure 7A: Three-Month (Nov-Jan) Forecast for Precipitation

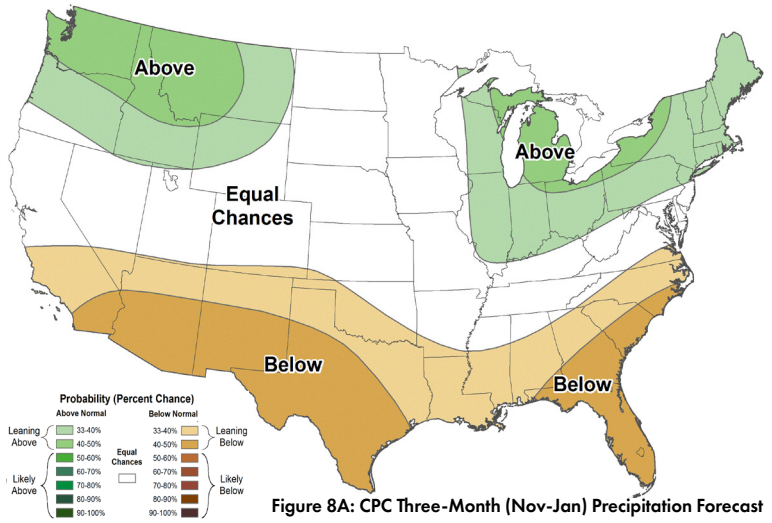


Figure 8A: CPC Three-Month (Nov-Jan) Precipitation Forecast

Temperature

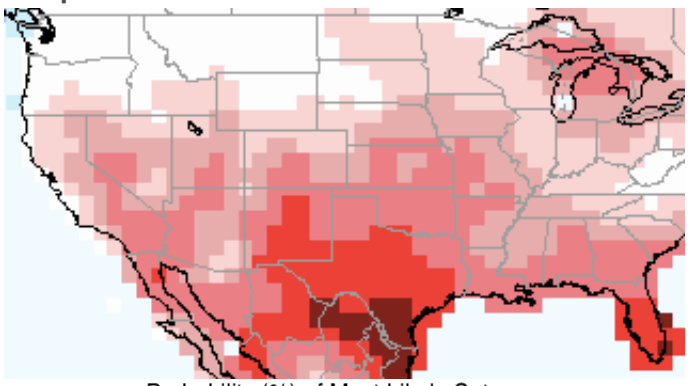


Figure 7B: Three-Month (Nov-Jan) Forecast for Temperature

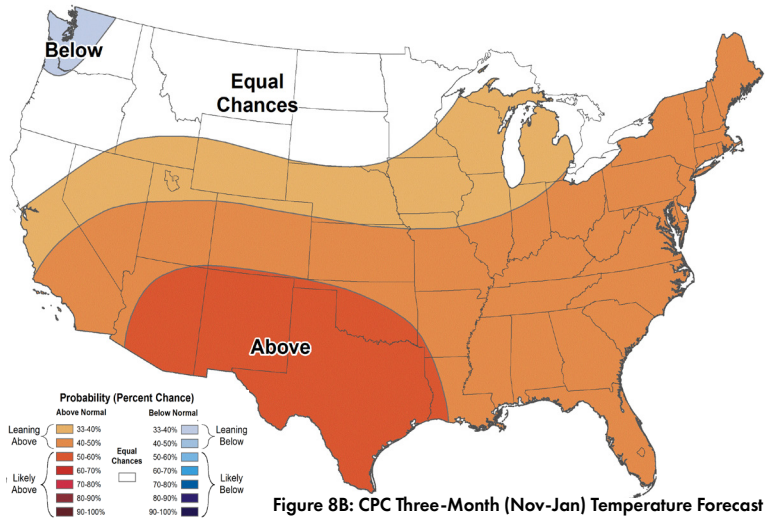


Figure 8B: CPC Three-Month (Nov-Jan) Temperature Forecast

Precipitation Forecasts: The three-month IRI outlook calls for increased chances of normal to above-normal precipitation in Arizona, and normal to below-normal precipitation in New Mexico and northern Mexico, (Fig. 7a). The three-month CPC outlook calls for increased chances of below-normal precipitation across the Southwest (Fig. 8a).

Temperature Forecasts: The three-month IRI outlook calls for increased chances of above-normal temperatures across the southwestern U.S. and northern Mexico (Fig. 7b). The three-month CPC outlook calls for increased chances of above-normal temperatures across the Southwest (Fig. 8b).

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

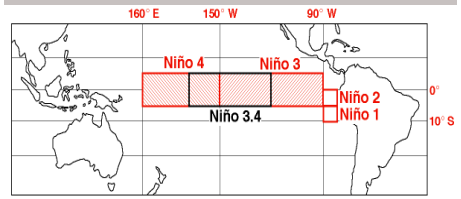
Figure 4
NOAA - Climate Prediction Center
cpc.ncep.noaa.gov

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

Sea surface temperature (SST) forecasts for Nov 2021 – Jan 2022 indicate further cooling across the equatorial Pacific (Fig. 1). Monthly Nino 3.4/4 anomalies were neutral (Fig. 2), but most ENSO outlooks now see La Niña conditions as having arrived. These conditions are expected to remain in place through winter 2021-2022, with some confidence they will last long enough to reach the La Niña threshold.

Forecast Roundup: On Oct 11 the Japanese Meteorological Agency (JMA) observed ENSO-neutral conditions continued and called for a 60-percent chance of La Niña conditions in fall and winter. On Oct 12 the Australian Bureau of Meteorology ENSO tracker shifted to La Niña ALERT status "due to continued cooling in the tropical Pacific Ocean and an increase in the number of climate models showing sustained La Niña conditions." On Oct 14 the NOAA Climate Prediction Center (CPC) ENSO status moved to a "La Niña Advisory" with an outlook calling for an 87-percent chance of La Niña during Dec 2021 – Feb 2022. On Oct 19 the International Research Institute (IRI) issued a Quick Look (Fig. 3), noting "The evolution of key oceanic and atmospheric variables is consistent with La Niña conditions" and issued a La Niña Advisory. The North American Multi-Model Ensemble (solid and dashed black line, Fig. 4) is ENSO-neutral but indicates a rapid swing to moderate La Niña in late 2021 and into 2022. A note that the International Multi-Model Ensemble (IMME) forecast borderline ENSO-neutral through winter.

Summary: The seasonal outlooks have shifted to near consensus on a La Niña event in winter 2021-2022. This is tied to cooling SSTs in the equatorial region, and oceanic/atmospheric coupling indicative of La Niña. The IMME is curious in its divergence from the NMME, but overall consensus centers on a La Niña event of weak to moderate intensity. There are lingering questions about whether conditions will last long enough to be classified as a La Niña event, but each month the forecasts are more confident the conditions will meet that threshold. La Niña winters are frequently warmer and drier than average in the Southwest, so this forecast is something to watch, given the drought conditions and cumulative precipitation deficits affecting the region.

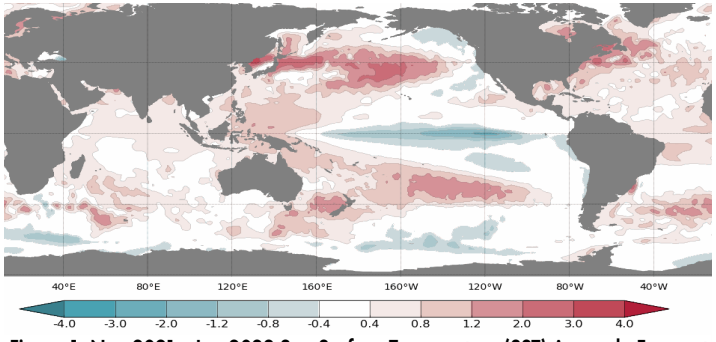


Figure 1: Nov 2021 - Jan 2022 Sea Surface Temperature (SST) Anomaly Forecast

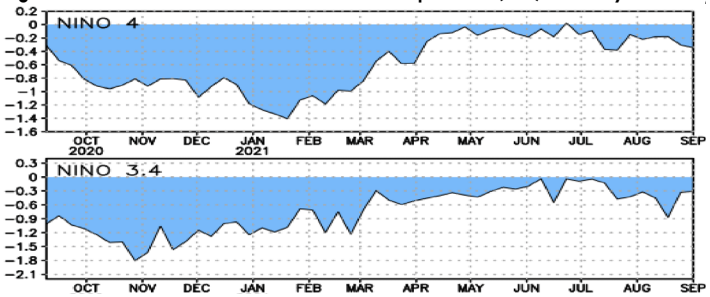


Figure 2: SST Anomalies in Niño Regions 3.4 & 4 (NCDC)

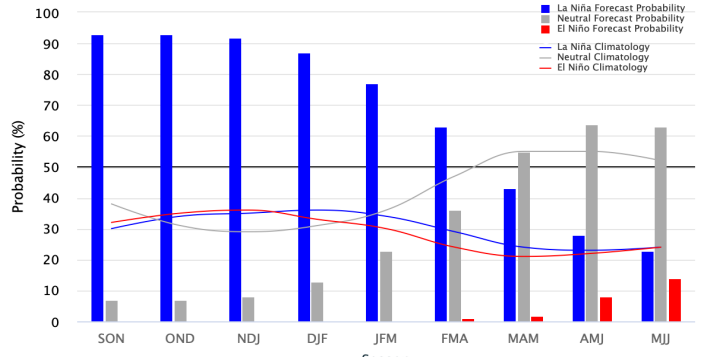


Figure 3: Early-Oct IRI/CPC Model-Based Probabilistic ENSO Forecast

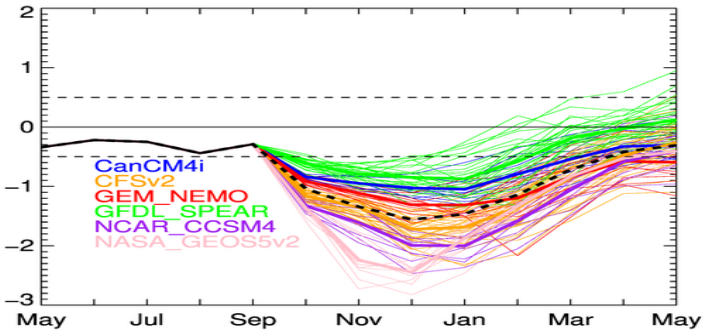


Figure 4: North American Multi-Model Ensemble Forecast for Niño 3.4

Online Resources

Figures 1-2
UA Climate Science Applications Program
cals.arizona.edu/climate
Data: PRISM

2021 Southest Monsoon Recap

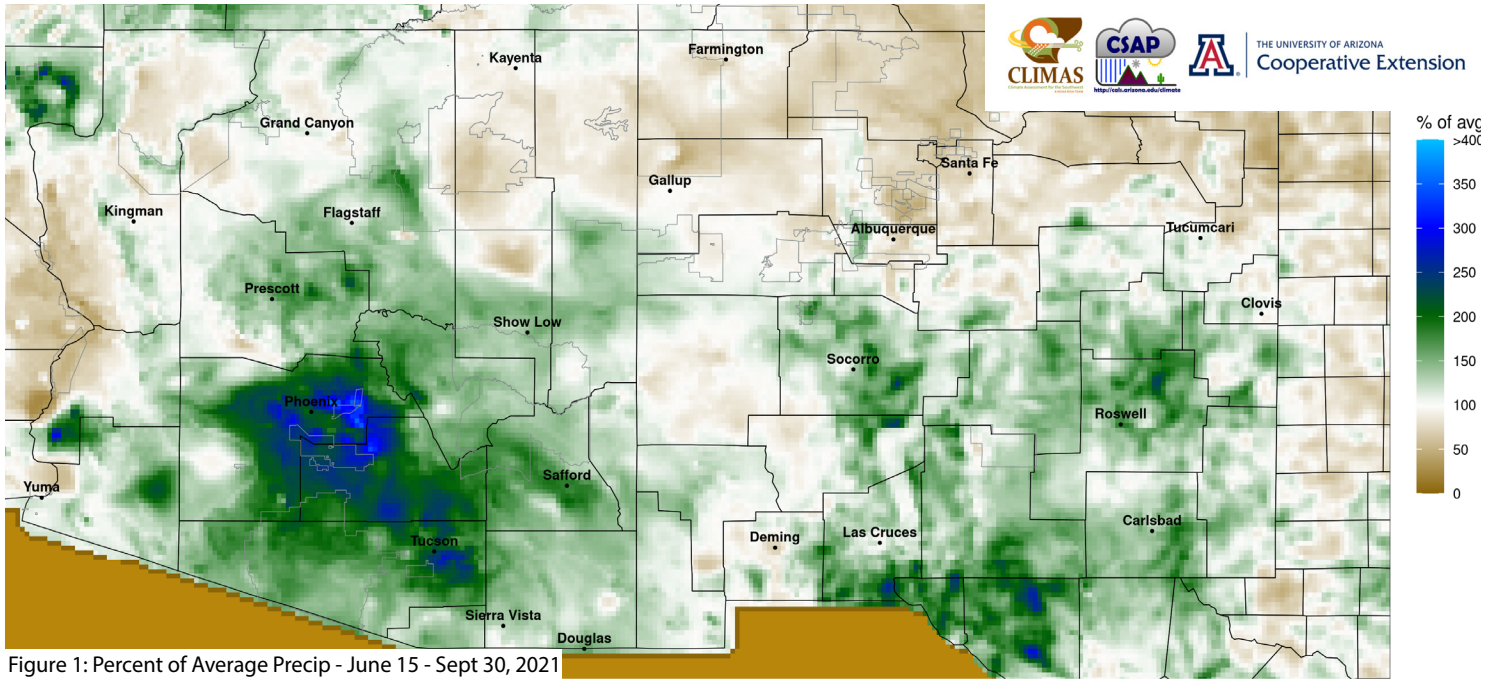


Figure 1: Percent of Average Precip - June 15 - Sept 30, 2021

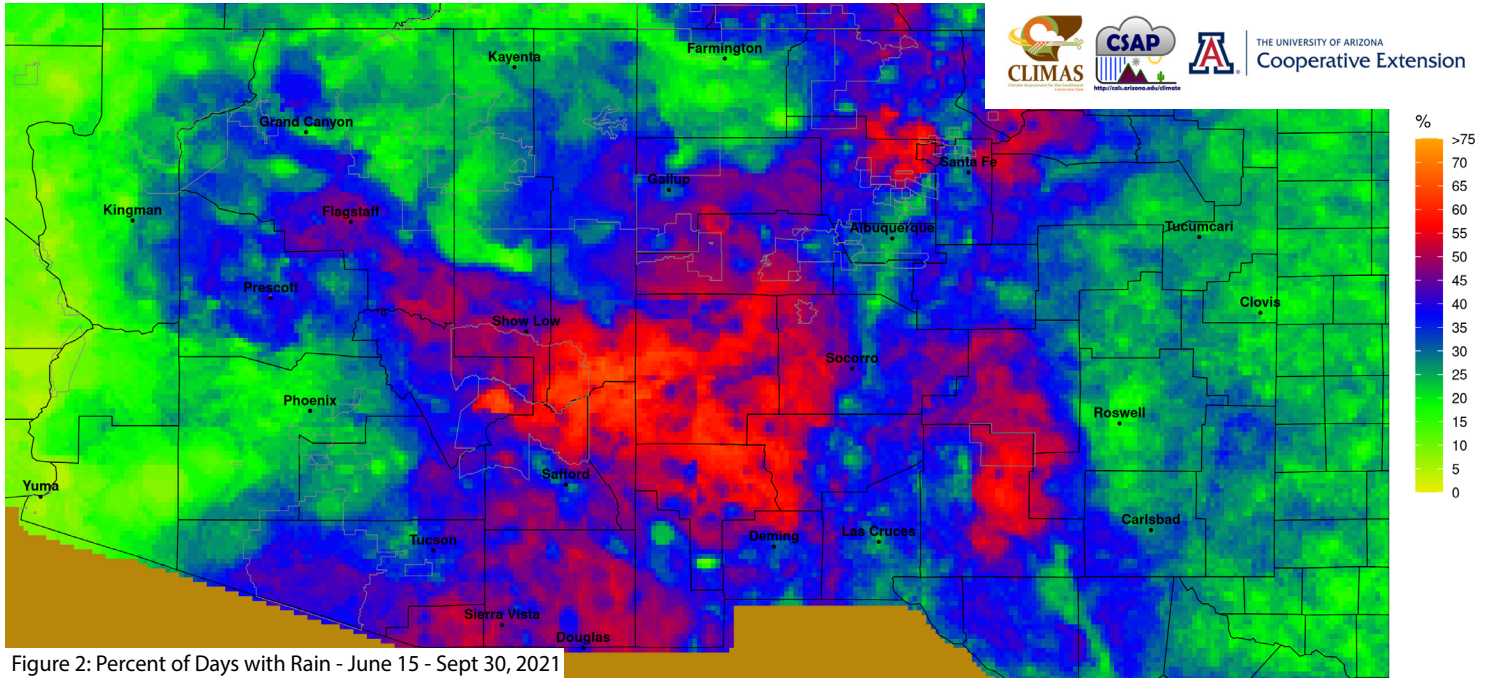


Figure 2: Percent of Days with Rain - June 15 - Sept 30, 2021

Online Resources

Figure 3
CLIMAS: Climate Assessment for the Southwest
climas.arizona.edu
Data: ACIS & MesoWest

2021 SW Monsoon Recap: Temperature, Dewpoint & Precipitation

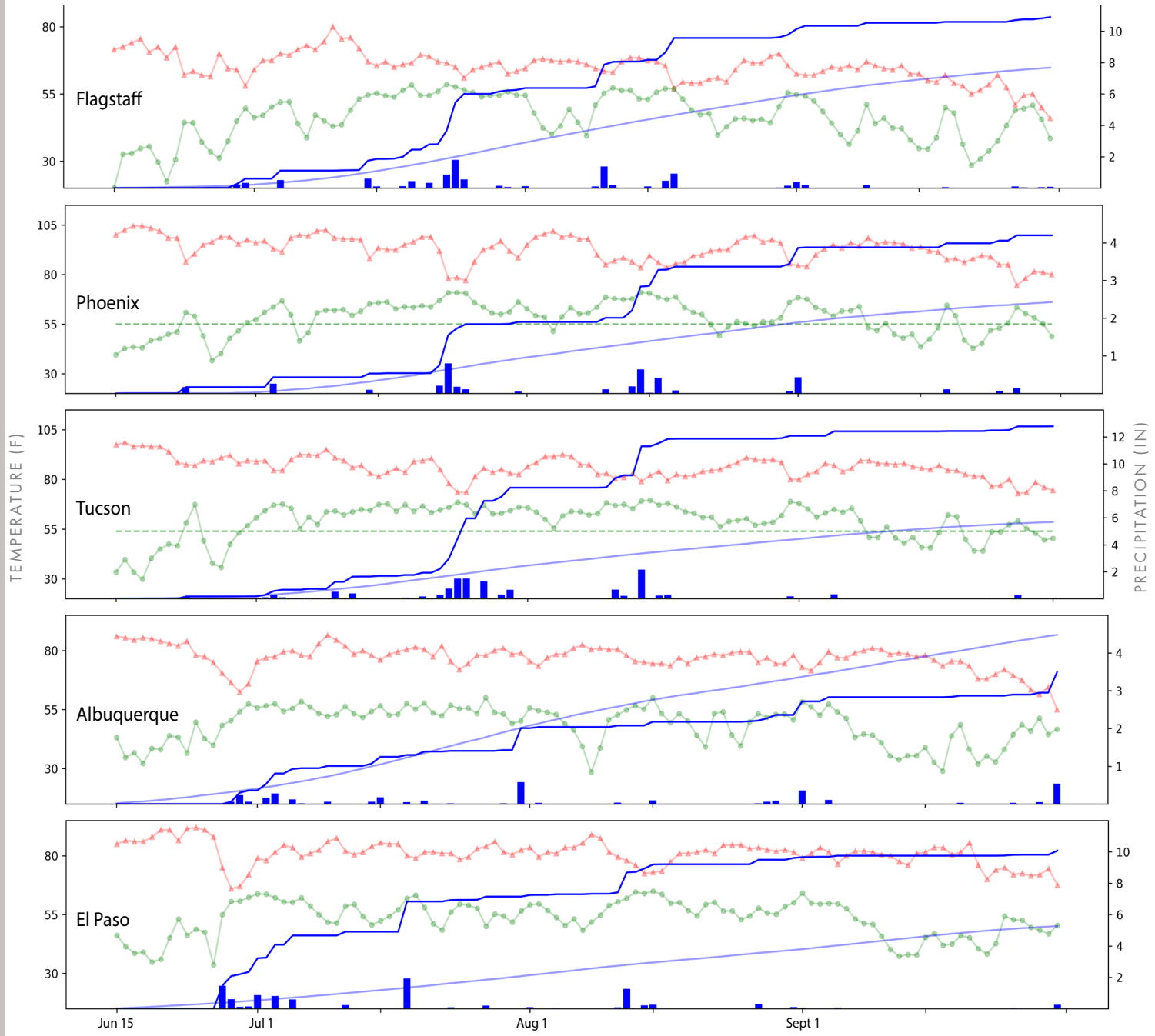


Figure 3: Daily Average Temperature and Dewpoint, Daily and Cumulative Precipitation - Jun 15 - Sept 30, 2021

Online Resources

Figure 4
CLIMAS: Climate Assessment for the Southwest
climas.arizona.edu
Data: NWS Monsoon Tracker

Figures 5-6
UA Climate Science Applications Program
cals.arizona.edu/climate
Data: PRISM

2021 Southest Monsoon Recap

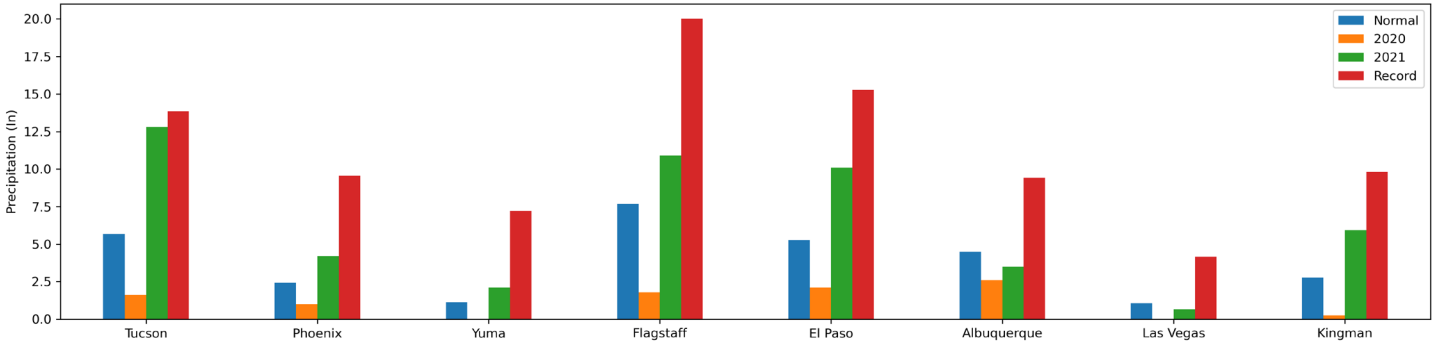


Figure 4: Normal, Recent (2020, 2021), and Record Monsoon Precipitation in the Southwest

What a difference a year makes! Percent of average and percent of days with rain for 2021 (Figs 1-2, p. 5) compared to 2020 (Figs. 5-6, p. 7) provide a stark reminder of the shift in monsoon precipitation was observed in the Southwest over the past two years. At the station level, some sites came close to the record, most sites recorded above normal, and nearly all recorded more precipitation in 2021 Vs. 2020 (see Fig. 4 for examples across the Southwest). The daily accumulation plots for select stations in the Southwest show when and how precipitation fell (Fig. 3, p. 6). For the most part, these totals were achieved through regular and persistent storm activity in July and August and not a few large events on just a few days.

2021 will be a hard act to follow, especially in the parts of the Southwest that saw near record totals. Regardless of the records, 2021 was a welcome and needed pivot from 2020.

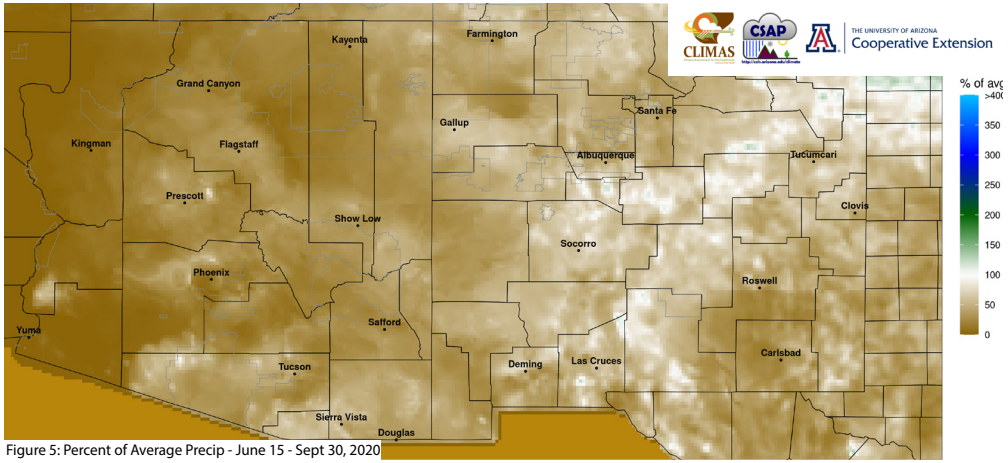


Figure 5: Percent of Average Precip - June 15 - Sept 30, 2020

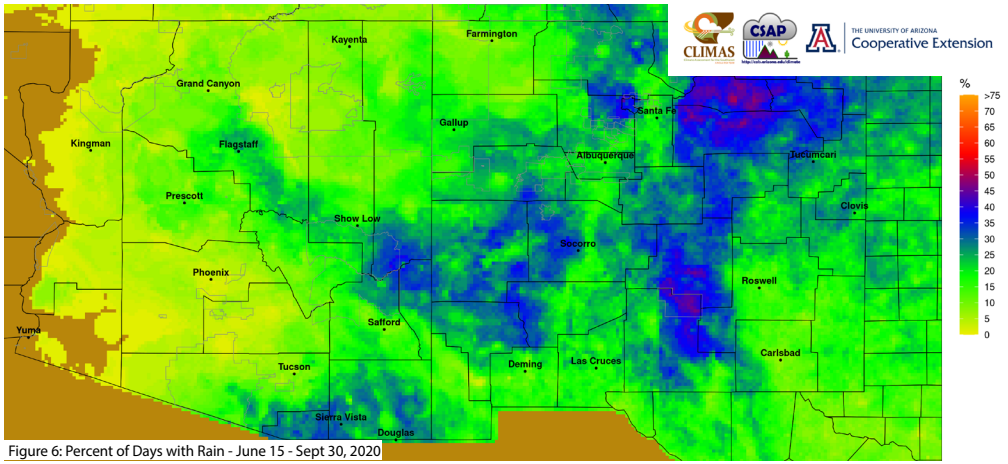


Figure 6: Percent of Days with Rain - June 15 - Sept 30, 2020

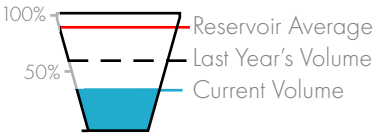
Online Resources

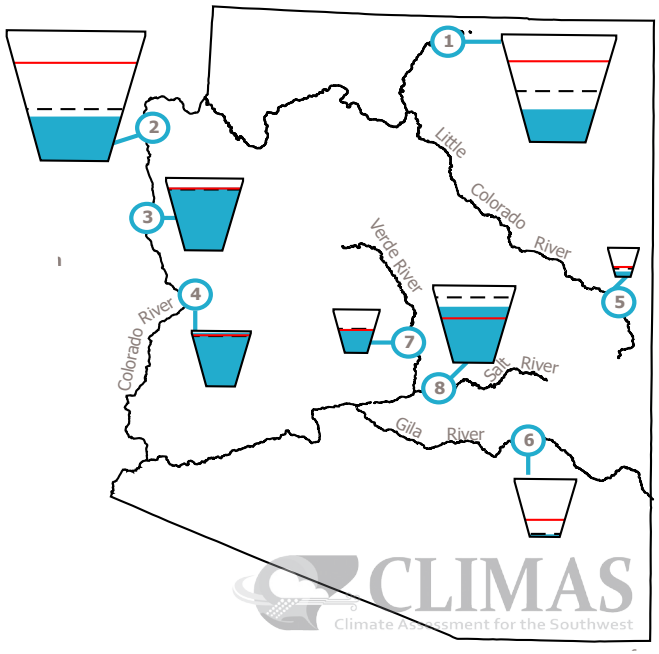
Portions of the information provided in this figure is available at the Natural Resources Conservation Service
www.wcc.nrcs.usda.gov/BOR/basin.html

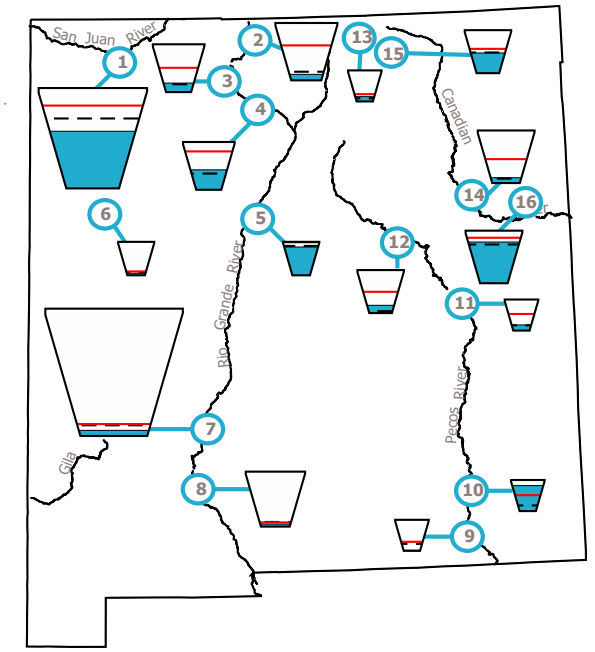
Contact Ben McMahan with questions/comments.

Reservoir Volumes

DATA THROUGH OCT 1, 2021
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	30%	7,257.7	24,322.0	-253.3
2. Lake Mead	34%	9,016.0	26,159.0	-22.0
3. Lake Mohave	87%	1,570.0	1,810.0	-145.0
4. Lake Havasu	96%	591.9	619.0	18.7
5. Lyman	17%	5.2	30.0	-0.3
6. San Carlos	4%	31.4	875.0	4.0
7. Verde River System	52%	148.4	287.4	3.8
8. Salt River System	72%	1,462.8	2,025.8	-19.7

*KAF: thousands of acre-feet

Reservoir	Capacity	Current Storage*	Max Storage*	One-Month Change in Storage*
1. Navajo	56%	950.6	1,696.0	-59.8
2. Heron	11%	44.2	400.0	-23.7
3. El Vado	18%	33.7	190.3	10.4
4. Abiquiu	41%	76.6	186.8	5.0
5. Cochiti	83%	41.4	50.0	0.0
6. Bluewater	6%	2.2	38.5	-0.1
7. Elephant Butte	5%	110.6	2,195.0	6.1
8. Caballo	4%	14.6	332.0	1.1
9. Lake Avalon	0%	0.0	4.5	0.0
10. Brantley	80%	33.9	42.2	-6.8
11. Sumner	17%	6.0	35.9	-2.0
12. Santa Rosa	18%	19.4	105.9	0.8
13. Costilla	15%	2.5	16.0	-1.5
14. Conchas	9%	23.7	254.2	-1.9
15. Eagle Nest	46%	36.5	79.0	-2.0
16. Ute Reservoir	76%	152	200	-6.0

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).

Southwest Climate Podcast

climas.arizona.edu/media/podcasts

iTunes

https://apple.co/3kHh8bf

Spotify

https://spoti.fi/3zZIvWu

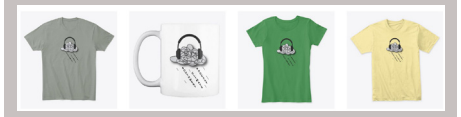
Android

https://bit.ly/2ILYHos

Stitcher

https://bit.ly/3nEWhHd

We also finally have podcast gear (shirts and mugs).



Order at: teespring.com/stores/the-southwest-climate-podcast.

Prices are the wholesale cost, so we don't make any money, but if you are interested in showing your support - or enjoying the (lack of a) monsoon in style, this is one way to do so.

The Southwest Climate Podcast

Sept 2021 Southwest Climate Podcast Is the (Generational) Monsoon Over?

In the September Edition of the CLIMAS Southwest Climate Podcast, Mike Crimmins and Zack Guido sit down to revisit last month's discussion of a generational monsoon. They check in around the region to see how various locations are faring and discuss the interesting patterns they've seen in monsoon activity so far. They put the totals to date into climatological context and rankings, to see who is experiencing a generational monsoon, vs. areas that are "just" above average (or who are lagging behind). They wrap with a discussion of "Is the Monsoon Over" - and talk about the reasons why you may/may not think so, and what the transition season means for the last few weeks of the monsoon (and the final seasonal rankings).

https://bit.ly/3lqRVnD

August 2021 Southwest Climate Podcast - 2021 - A Generational Monsoon?

In the August 2021 edition of the CLIMAS Southwest Climate Podcast, Mike Crimmins and Zack Guido sit down to discuss the "monsoon that comes to you" (i.e. it's just about everywhere, and it just keeps coming!). They discuss the (record) July for some areas, as well as the well above average conditions around much of the region. They also deconstruct the elements that are feeding into this persistent monsoon rainfall and take a deep dive into a few of the events that have contributed to impressive totals. They wrap up with a discussion of outlooks for the rest of the season, whether any stations might hit record monsoon totals (Tucson is definitely in the running), and what this has meant for the monsoon fantasy game (suffice to say, the guesses for July did not anticipate the record wet conditions).

https://bit.ly/3ANUeHC

1075' - Shortage on the Colorado River Ep. 1 - Management of the Colorado River

Originally released in 2014, this CLIMAS podcast series that explores what the first ever shortage declaration on the Colorado River would mean to those living in the Southwest. The first episode takes a broad view of the Colorado River Basin, exploring how the river is managed, who uses the water, and what a potential shortage could mean for the system. The guest is Doug Kenney, Director of the Western Water Policy Program at the University of Colorado School of Law.

https://bit.ly/3xVzXhu

Online Resources

Figure 1
Climate Program Office
cpo.noaa.gov

RISA Program Homepage

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

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 Institute of the Environment—is a collaboration between the University of Arizona 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.

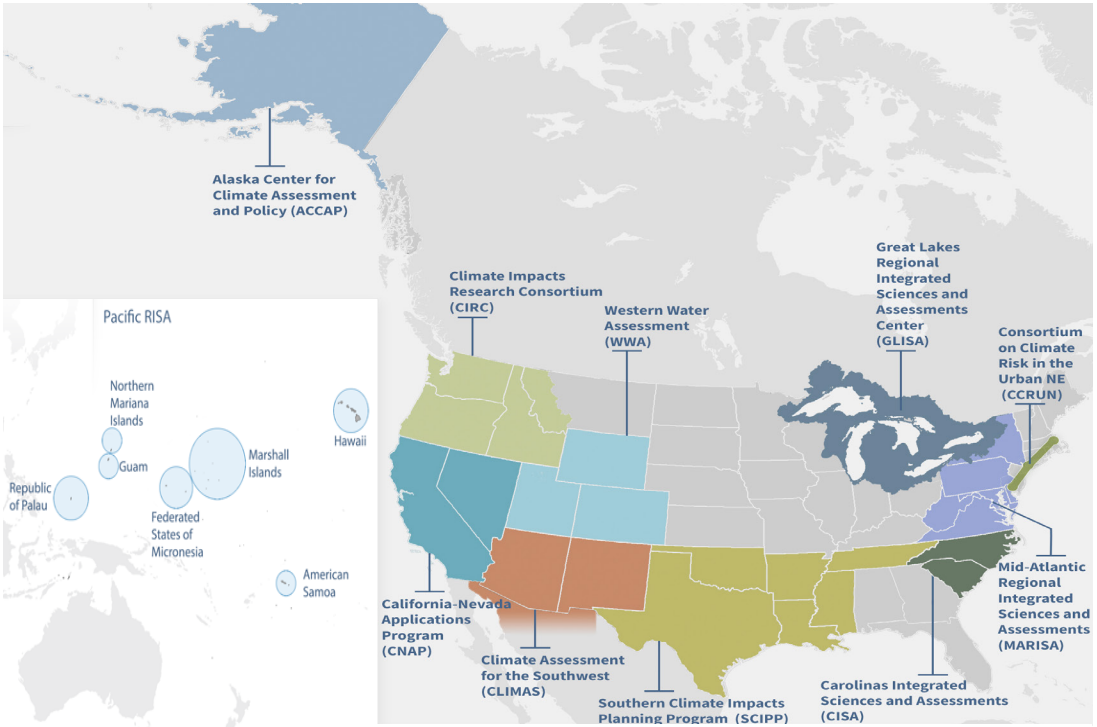


Figure 1: NOAA Regional Integrated Sciences and Assessments Regions