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July Southwest Climate Outlook

June Precipitation and Temperature Recap: June precipitation was variable in Arizona, ranging from record driest to above average, with a majority of the region recording average to below average precipitation, while New Mexico was mostly average with pockets of both below and above average precipitation (Fig. 1a). June temperatures were mostly average in Arizona and New Mexico, with pockets of above and below average temperatures (Fig. 1b). Daily average temperature anomalies for Jun 1 – Jul 15 demonstrate the fluctuations above and below average (Fig. 2).

Seasonal Precipitation and Temperature Recap: Cumulative precipitation for April-June was mostly above average to much above average in Arizona, and below average to above average in most of New Mexico (Fig. 3a). Temperatures for the same period were average to below average in Arizona, and average to above average in New Mexico (Fig. 3b).

Drought: Water year precipitation to date was above average across much of the Southwest, with Arizona, Utah, Nevada, and southern California doing particularly well, while other areas (i.e. parts of Colorado and New Mexico) were closer to average and even below average (Fig. 4). This extended period of above average precipitation is reflected in the Jul 9 U.S. Drought Monitor (USDM), which continues to document widespread improvements in regional drought conditions in the western United States, and with most of the region no longer classified as experiencing drought (Fig. 5).

Water Supply: Most of the reservoirs in the region are at or above the levels recorded at this time last year, but most reservoirs are also below their long-term average (see reservoir storage on p. 7). This highlights the short term improvement in drought conditions and reservoir storage, as well as the accumulated deficits linked to the persistent drought affecting the region for much of the last 20 years.

Wildfire, Health, and Safety: The onset of monsoon activity, including precipitation and increased humidity, has more or less tamped down elevated wildfire risk in much of the Southwest. The National Interagency Fire Center outlook for August calls for average fire risk across the region. In terms of wildfire acres burned, lightning caused fires in Arizona and New Mexico, as well as human caused fires in New Mexico, are all below their long term annual median acres burned for 2019 to date, while human caused fires in Arizona are well above the annual median acres burned (Fig. 6).

El Niño Tracker: After multiple months of outlooks that hinted at an El Niño event that might last through 2019 and into 2020, this event is currently forecast to return to ENSO-neutral conditions this summer (see ENSO-tracker on p. 3 for details).

Precipitation and Temperature Forecast: The three-month outlook for August through October calls for increased chances of below-normal precipitation in parts of western Arizona, with equal chances of above- or below-normal precipitation in the rest of Arizona, New Mexico, west Texas, and northern Mexico (Fig. 7, top). The three-month temperature outlook calls for increased chances of above-normal temperatures across most of the U.S. Southwest and northern Mexico (Fig. 7, bottom).

Tweet July 2019 SW Climate Outlook

CLICK TO TWEET

JUL2019 @CLIMAS_UA SW Climate Outlook, The End of El Niño, Monsoon Tracker, AZ & NM Reservoir volumes, bit.ly/32wQbiJ #SWclimate #AZWX #NMWX

Online Resources

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

Figures 2,6
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 7
International Research Institute for Climate and Society
iri.columbia.edu

July 2019 SW Climate Outlook

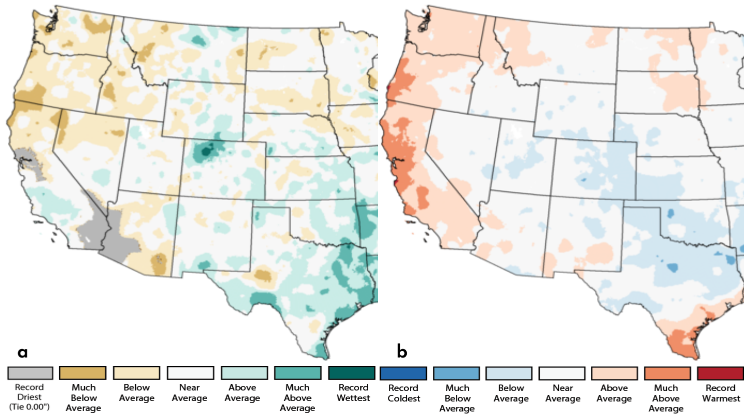


Figure 1: June 2019 Precipitation (a) & Temperature Ranks (b)

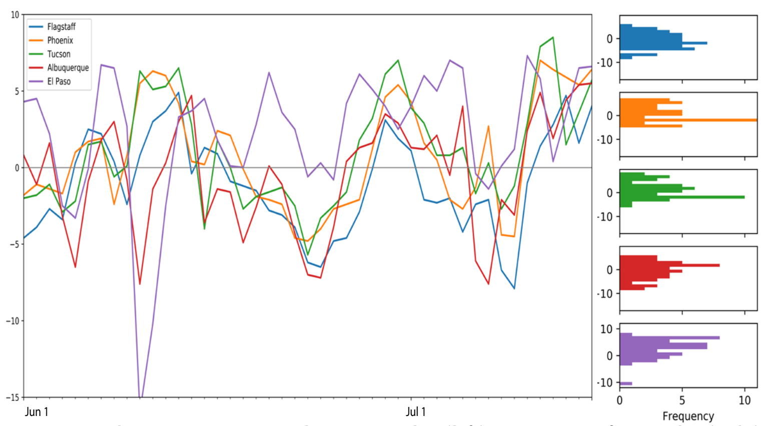


Figure 2: Daily Temperature Anomalies Jun 1 - Jul 15 (left) & Frequency of Anomalies (right)

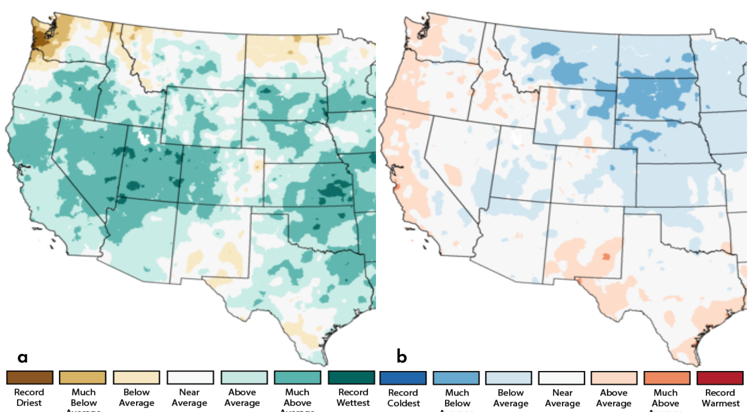


Figure 3: Apr - Jun 2019 Precipitation (a) & Temperature Ranks (b)

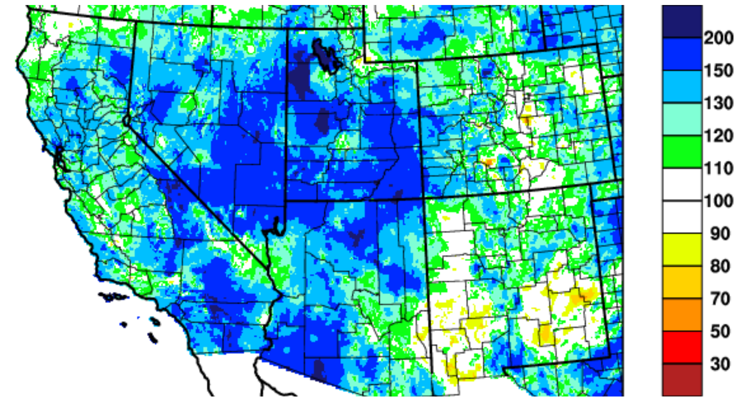


Figure 4: Oct 2018 - Jun 2019 - Percent of Normal Precipitation

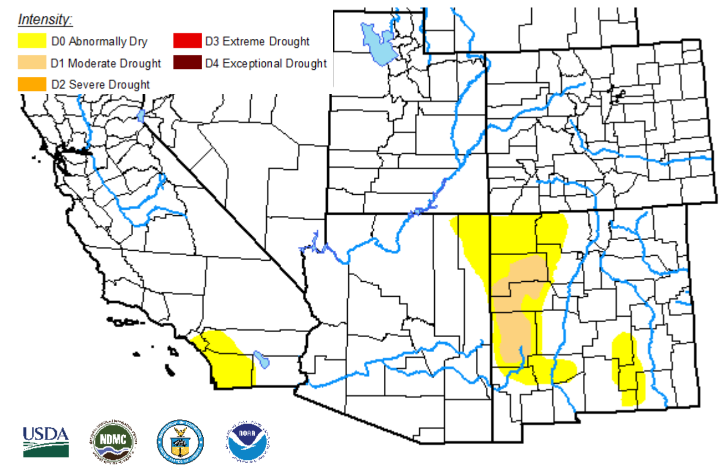


Figure 5: US Drought Monitor - Jul 9, 2019

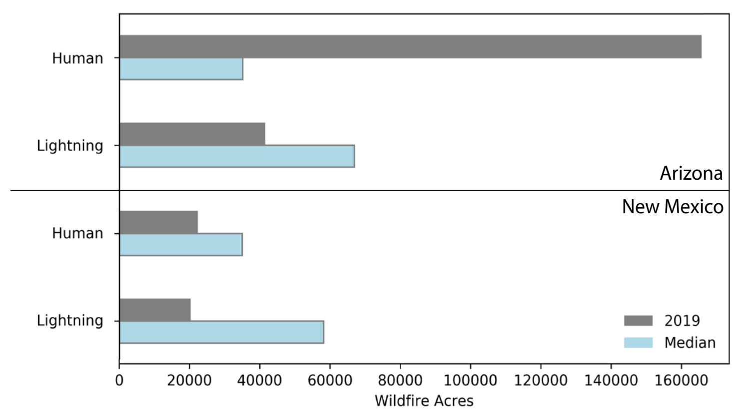


Figure 6: Wildfire Acres Burned to Date (As of Jul 11, 2019)

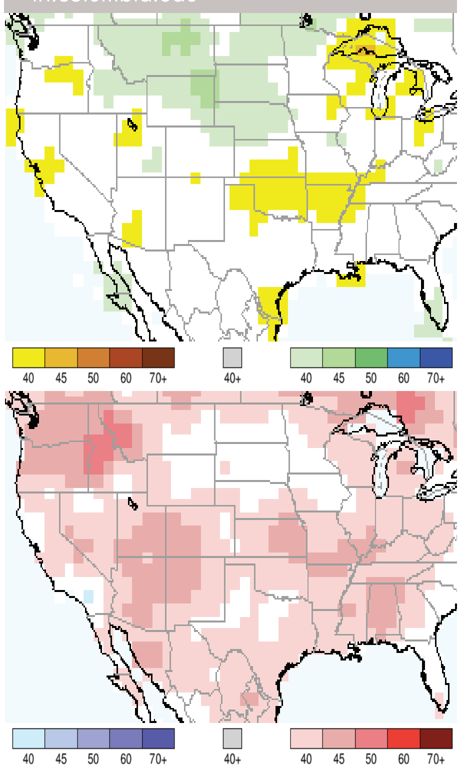


Figure 7: Three-Month (ASO) Forecast for Precipitation (top) and Temperature (bottom)

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

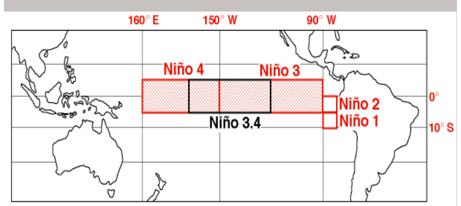
Figure 4
NOAA - Climate Prediction Center
cpc.ncep.noaa.gov

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/

El Niño Tracker

Forecast Roundup: Seasonal outlooks and forecasts focused on sea surface temperature (SST) anomalies and other oceanic and atmospheric indicators, all of which had generally remained consistent with a weak El Niño event (Figs. 1-2), at least until recently. On July 9, the Australian Bureau of Meteorology ended their ENSO Outlook and returned to 'inactive' status, identifying ENSO-neutral as the most likely outcome in 2019. On July 10, the Japanese Meteorological Agency (JMA) identified the end of this El Niño event, mostly due to the rapid dissipation of SST anomalies, as well as the return to normal for other atmospheric indicators. They called for a 60-percent chance of ENSO-neutral conditions to continue into Fall 2019. On July 11, the NOAA Climate Prediction Center (CPC) maintained their El Niño advisory based on the SST anomalies, but trends in oceanic and atmospheric conditions led them to expect this event would transition to ENSO-neutral in the next few months. On July 11, the International Research Institute (IRI) issued an ENSO Quick Look (Fig. 3), highlighting above-average SSTs consistent with a weak El Niño, but with most models predicting a transition to ENSO-neutral status by the end of summer. The North American Multi-Model Ensemble (NMME) shifted considerably in the last month, and now points towards a rapid decline to ENSO-neutral status by early fall (Fig. 4).

Summary: El Niño conditions are still within the range of a weak event based on SST anomalies, but most forecasts and outlooks describe this event as over, or that it will be soon. This is a quick shift compared to forecasts from the last few months, which identified the persistence of El Niño through 2019 as the most likely scenario, based on SST anomalies and other oceanic and atmospheric indicators. The swing towards ENSO-neutral was tied to the rapid dissipation of warmer waters in the ocean, and a return to mostly normal atmospheric conditions. Seasonal outlooks had been calling for above average precipitation in late summer and early fall, likely tied to the increased chance of enhanced tropical storm activity in the eastern pacific associated with El Niño. Now that a return to ENSO-neutral is all but certain the role that El Niño might have played in enhancing pacific tropical storms is less relevant. This does not necessarily mean there is an increased chance of drier than normal conditions, but it does mean that one source of moisture and storm activity that has tended to bring increased chances of precipitation into the Southwest, especially in late summer and early fall, is effectively off the table.

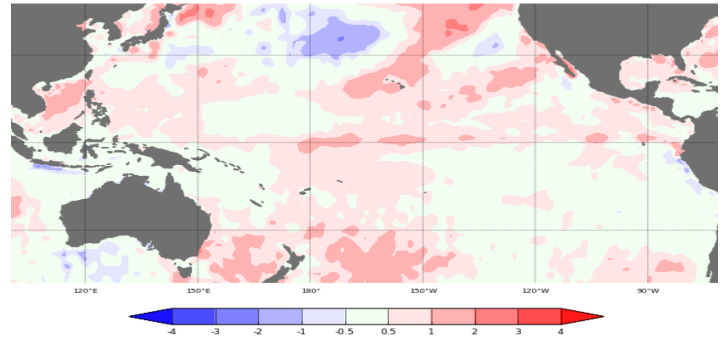


Figure 1: June 2019 Sea Surface Temperature (SST) Anomalies

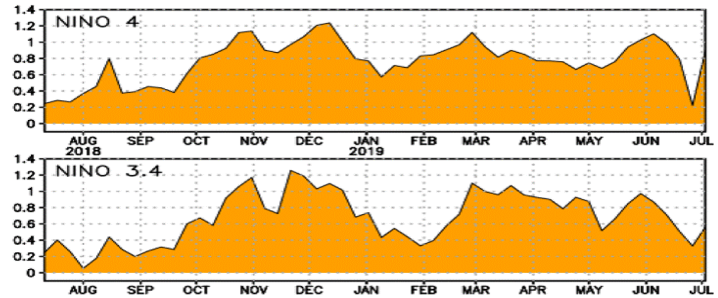


Figure 2: SST Anomalies in Niño Regions 3.4 & 4 (NCDC)

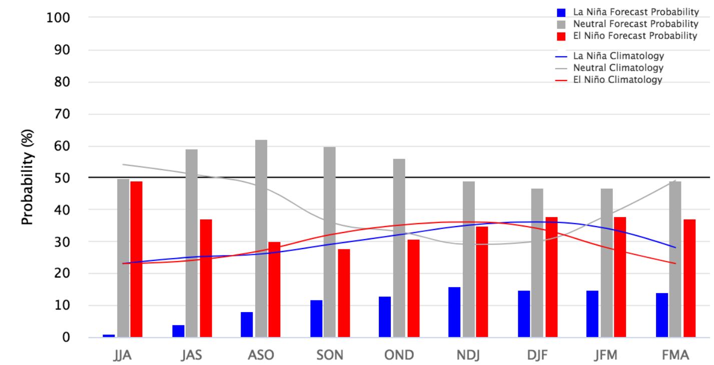


Figure 3: Early-July IRI/CPC Model-Based Probabilistic ENSO Forecast

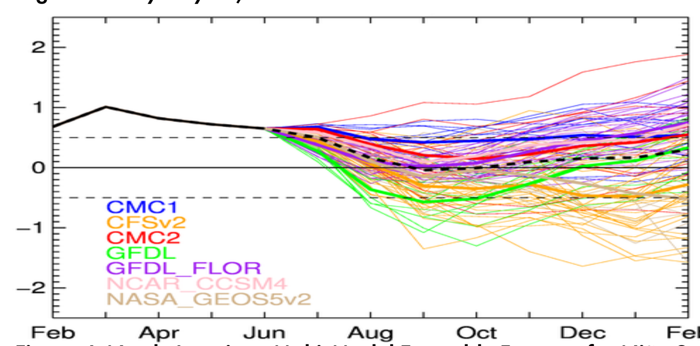


Figure 4: North American Multi-Model Ensemble Forecast for Niño 3.4

Online Resources

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

Southwest Climate Podcast
July 2019 - Monsoon MiniPod - The Pesky Trough Edition
Mike Crimmins and Zack Guido are back for a special mini-podcast focused on the onset of the monsoon. They discuss recent conditions and consider:
1) Has the monsoon started?
2) Why or why not? and
3) What data helps inform a perspective on monsoon onset (along with what this might mean for the rest of the season)?
climas.arizona.edu/media/podcasts

Monsoon Tracker

Given the spatial variability of the monsoon, single weather stations are an imperfect measure. For example, if it rains at the station and not in surrounding areas or vice versa. They do provide an opportunity to track long term averages compared to the current year. Figure 1 compares 2019 precipitation to date with 2018 and climatology. This reveals 2019 is lagging behind average in terms of precipitation and is also a significant departure from 2018's widespread activity by mid-July. Dewpoint temperatures and daily precipitation for the same five stations (Fig. 2) illustrate that while increased dewpoint temperatures do not guarantee monsoon precipitation, it is rare to see monsoon precipitation in the absence of these elevated dewpoint temperatures.

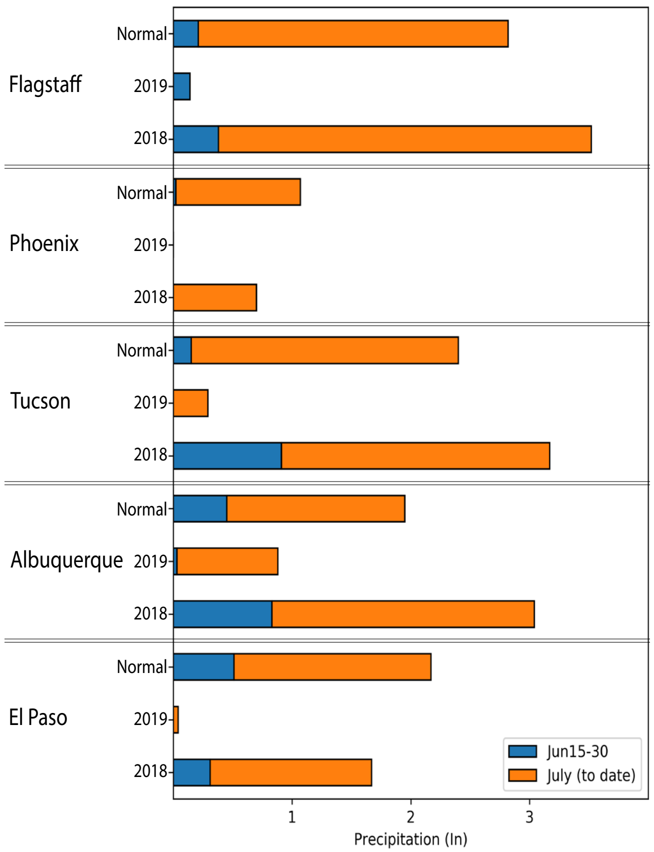


Figure 1: Monthly Monsoon Precipitation Totals - 2018, 2019 & Average

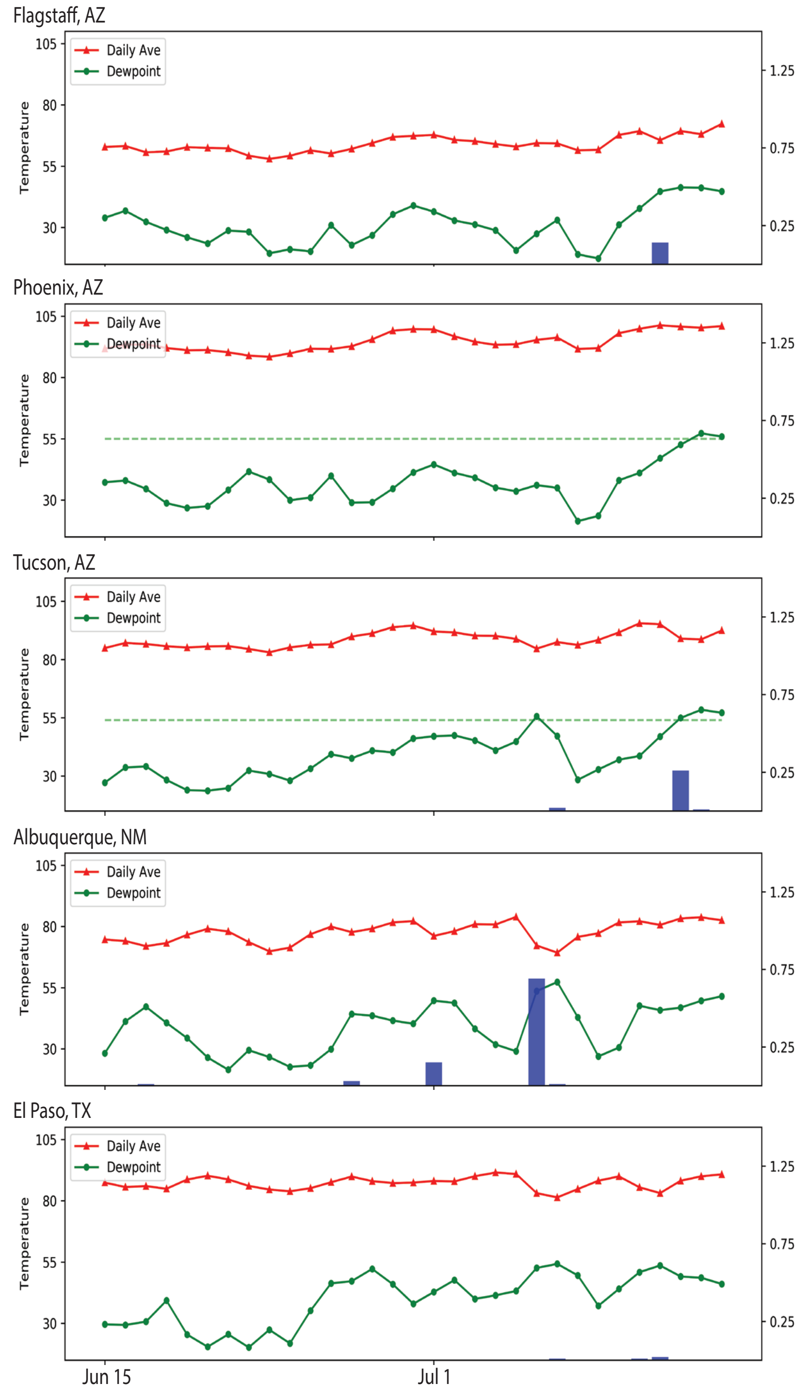


Figure 2: Dew Point and Daily Average Temperature, Daily Precipitation - Jun 15 - Jul15, 2019

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 Tracker (cont.)

Regional monsoon precipitation totals (Fig. 3) demonstrate a relatively slow start, with most of the Southwest lagging behind average accumulated precipitation through mid-July (Fig. 4). There is still plenty of time however, since monsoon activity typically intensifies in July and August, and with many locations experience their monsoon midpoint* in August. An early start can boost cumulative totals, but a late start does not necessarily mean decreased activity over the entire monsoon.

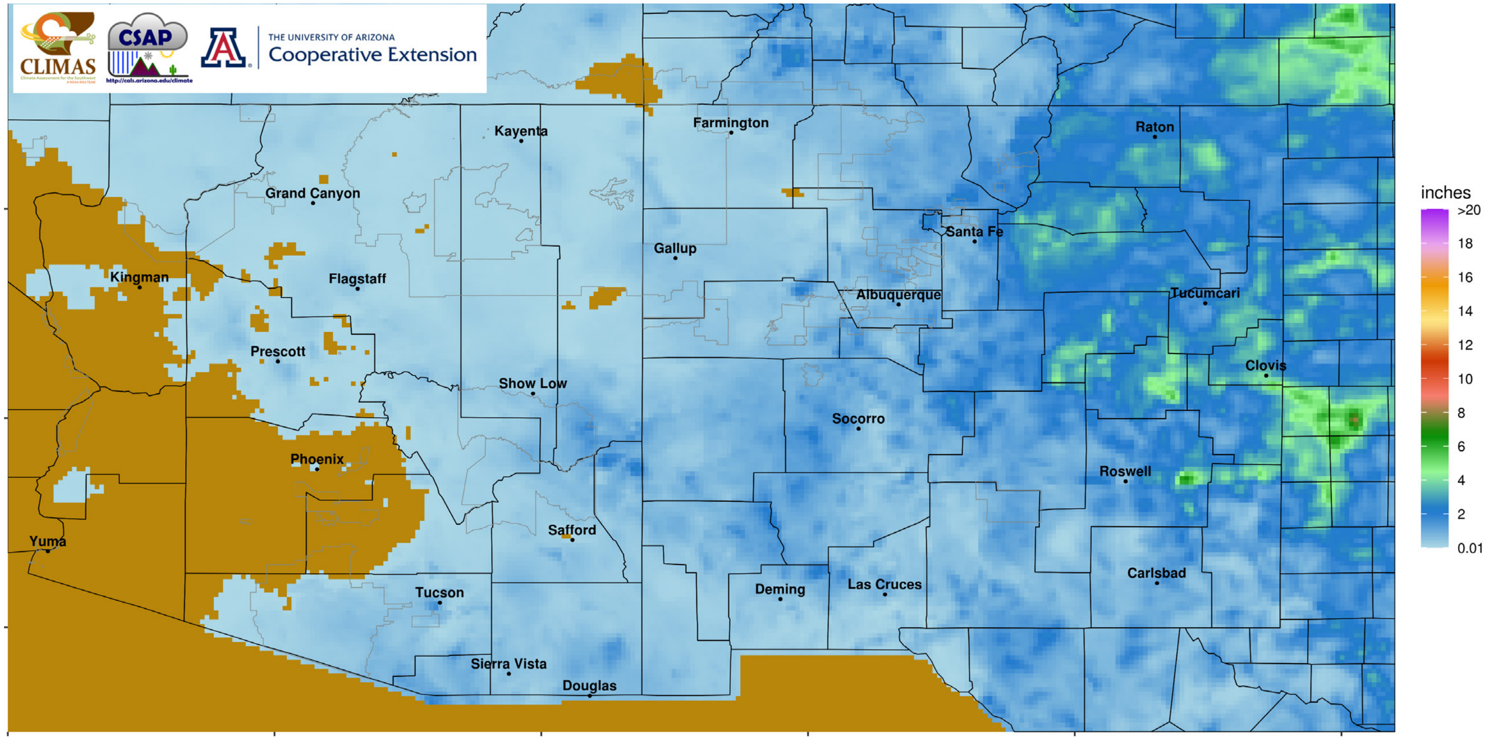


Figure 3: Total Precipitation Jun 15 - Jul 16 (PRISM Data from RCC-ACIS)

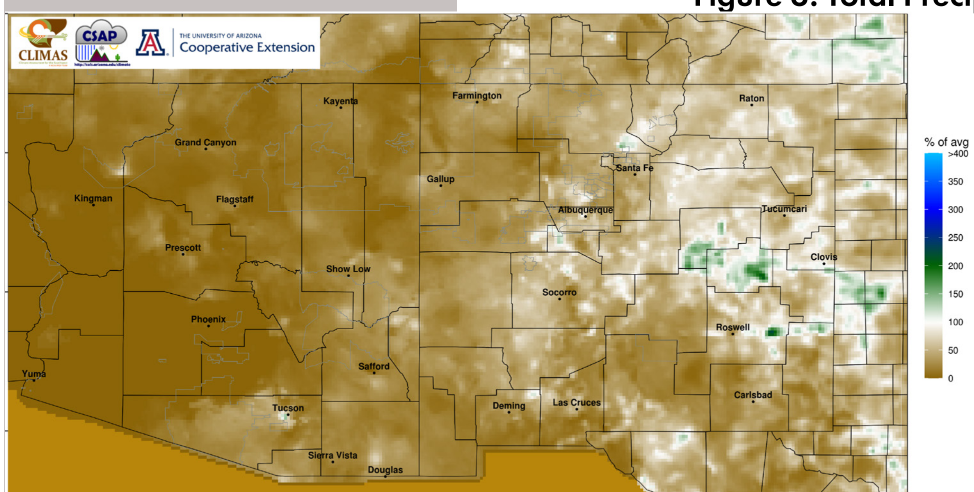


Figure 4: Precipitation percent of Normal Jun 15 - Jul 16 (PRISM Data from RCC-ACIS)

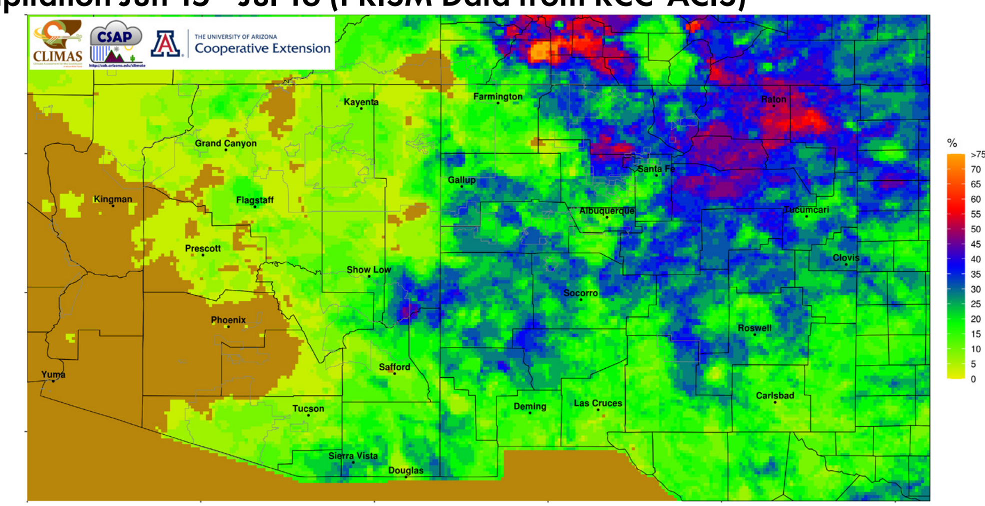


Figure 5: Percent of days with rain Jun 15 - Jul 16 (PRISM Data from RCC-ACIS)

Online Resources

Figure 1
International Research Institute for Climate and Society
journals.ametsoc.org/doi/abs/10.1175/2007JCLI1762.1

Figures 2a-2b
Monsoon Definition & Progression
National Weather Service - Tucson
wrh.noaa.gov/twc/monsoon/monsoon.php

Figure 3
CLIMAS: Climate Assessment for the Southwest
climas.arizona.edu

NWS Tucson has an excellent extended explanation of seasonal atmospheric dynamics that drive monsoon progression.
wrh.noaa.gov/twc/monsoon/monsoon_info.php

Southwest Climate Podcast
June 2019 - May Astonishment & Monsoon Preseason Edition
climas.arizona.edu/media/podcasts

Monsoon Onset

In 2008, the National Weather Service (NWS) changed the definition of the start of the Southwest monsoon from a variable date based on locally measured conditions to a fixed date of June 15 (and a fixed end date of Sept 30). This allowed for a clear delineation of the period of monsoon activity (108 days) and focused NWS's messaging strategy as it pertains to the expected hazards during that period, which include extreme heat, strong winds, dust storms, flash flooding, lightning, and wildfires (see monsoon safety awareness hub at NWS Tucson).

Prior to 2008, the flexible start date reflected the seasonal progression of the monsoon, with a considerable temporal gradient across the region (Fig. 1).

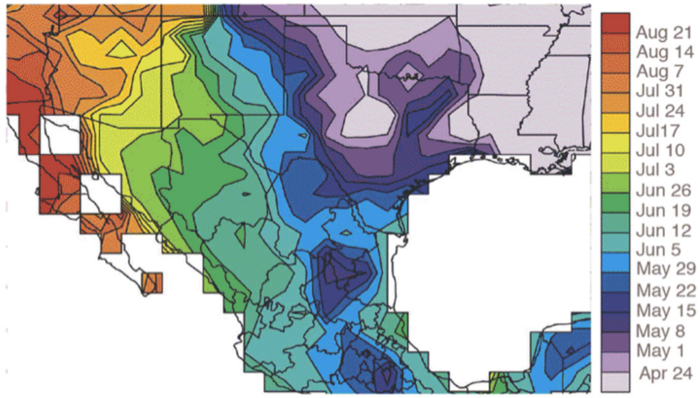


Figure 1: Historical Monsoon Onset Date

This gradient is linked to seasonal atmospheric patterns and the establishment of the "monsoon ridge" in the Southwest (Figs. 2a-b, also see sidebar for link to NWS pages). The heating of the complex topography of the western U.S. with the increasing sun angle and contrast with the cooler water of the adjacent Pacific Ocean lead to the establishment of this upper-level ridge of high pressure over the Southwest U.S. (also known as Four Corners High). The flow around this upper-level ridge shifts from a dry southwesterly fetch in May to a moisture-rich southerly-southeasterly fetch in late June/early July (see figures, right).

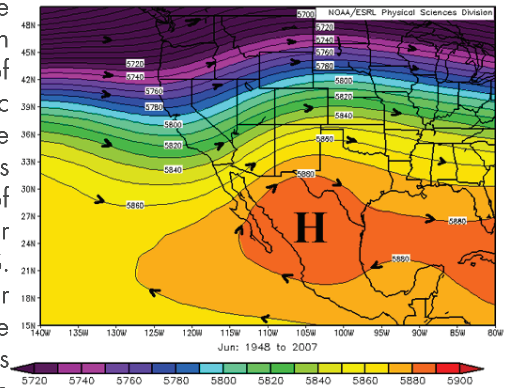


Figure 2a: NCEP/NCAR Mean 500mb Geopotential Height - Jul (1948-2007)

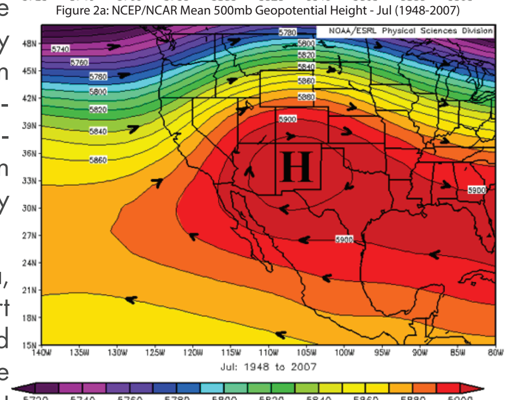


Figure 2b: NCEP/NCAR Mean 500mb Geopotential Height - Jul (1948-2007)

In Southern Arizona, the monsoon start date was based on the average daily dewpoint temperature. Phoenix and Tucson NWS offices used the criteria of three consecutive days of daily average dewpoint temperature above a threshold (55 degrees in Phoenix, 54 degrees in Tucson) to define the start date of the monsoon. As shown in Figure 3 the dewpoint temperature criterion produced start dates ranging from mid-June to late July over the period of record (1949-2016).

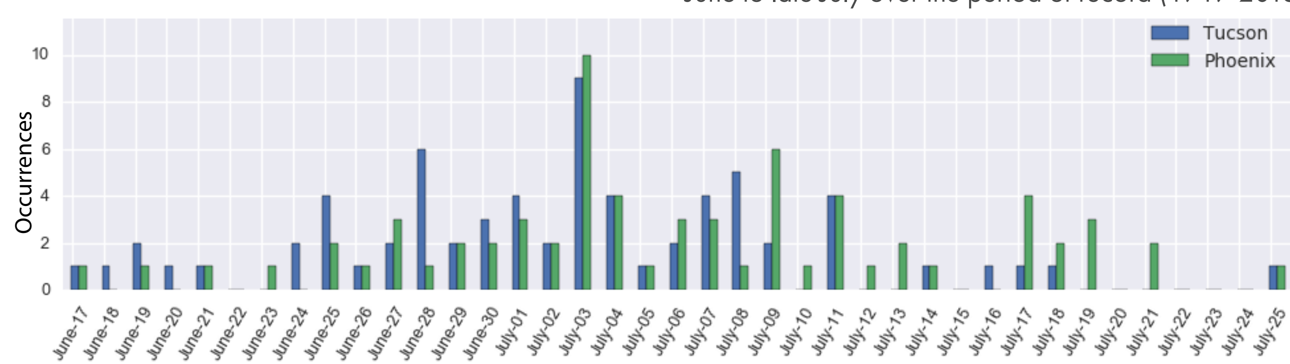


Figure 3: Monsoon Onset (as defined by dewpoint thresholds) in Tucson and Phoenix, Frequency by Date (1949-2016)

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.

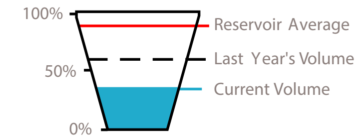
The map gives a representation of current storage for reservoirs in Arizona and New Mexico. Reservoir locations are numbered within the blue circles on the map, corresponding to the reservoirs listed in the table. The cup next to each reservoir shows the current storage (blue fill) as a percent of total 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).

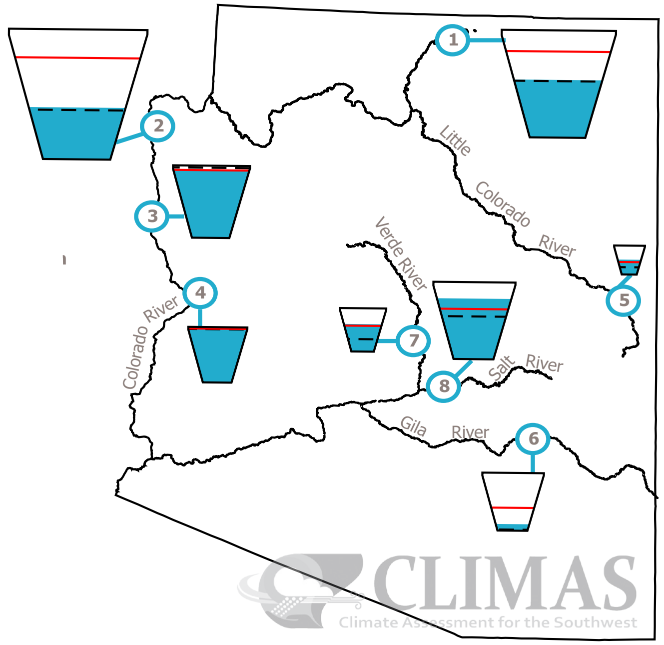
The table details more exactly the current capacity (listed as a percent of maximum storage). Current and maximum storage are given in thousands of acre-feet for each reservoir. One acre-foot is the volume of water sufficient to cover an acre of land to a depth of 1 foot (approximately 325,851 gallons).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

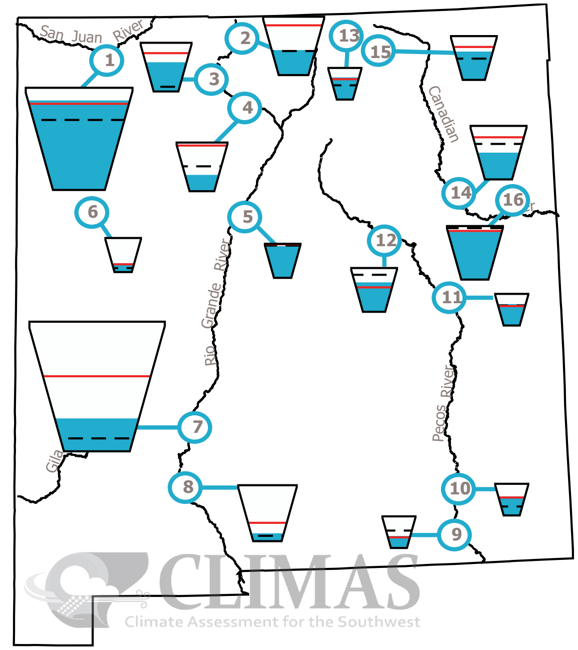
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS).

Reservoir Volumes

DATA THROUGH JULY 1, 2019
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	53%	12,914.4	24,322.0	2571.2
2. Lake Mead	40%	10,405.0	26,159.0	-143.0
3. Lake Mohave	94%	1,698.0	1,810.0	-11.0
4. Lake Havasu	96%	591.5	619.0	-2.6
5. Lyman	51%	15.2	30.0	-0.9
6. San Carlos	11%	97.3	875.0	-32.2
7. Verde River System	63%	181.1	287.4	-39.1
8. Salt River System	79%	1,593.8	2,025.8	-23.3

*KAF: thousands of acre-feet

* in KAF = thousands of acre-feet

Reservoir	Capacity	Current Storage*	Max Storage*	One-Month Change in Storage*
1. Navajo	88%	1500.6	1,696.0	221.8
2. Heron	42%	169.6	400.0	53.9
3. El Vado	60%	113.5	190.3	52.7
4. Abiquiu	33%	61.7	186.8	-22.9
5. Cochiti	93%	46.3	50.0	0.6
6. Bluewater	25%	9.7	38.5	-1.2
7. Elephant Butte	25%	551.3	2,195.0	65.0
8. Caballo	14%	47.8	332.0	-8.0
9. Lake Avalon	38%	1.7	4.5	1.7
10. Brantley	60%	25.2	42.2	-4.6
11. Sumner	68%	24.3	35.9	-2.4
12. Santa Rosa	67%	71.1	105.9	13.9
13. Costilla	70%	11.2	16.0	3.1
14. Conchas	50%	126.6	254.2	-3.7
15. Eagle Nest	65%	51.0	79.0	0.9
16. Ute Reservoir	89%	178	200	-3.0

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

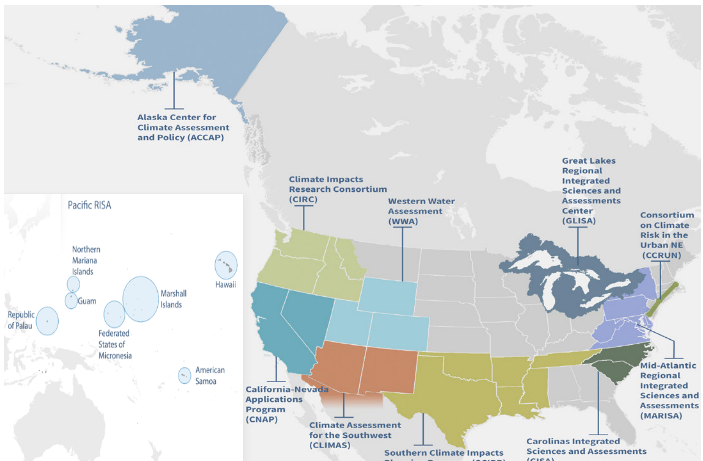


Figure 1: NOAA Regional Integrated Sciences and Assessments Regions

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.

RISA Program Video on CLIMAS Dust Research

https://youtu.be/ENylO-coRKg

CLIMAS Colloquium Presentations on YouTube

Dave DuBois and Jaylen Fuentes: Preparing for the next dust storm: Collaborations with state and federal agencies with roadway dust hazards

https://youtu.be/2csJSTl1YBA

Zahra (Vida) Ghodisidah: Modeling of Dust Emissions over the Chihuahuan Desert

https://youtu.be/kFmIGqZv8EU

Josue Gutierrez: Dust Classification from Weather Observation Stations and Remote Sensing

https://youtu.be/Wlou8gsOSJQ

Heidi Brown: Water Harvesting as Maladaptation with Respect to Vector-borne Diseases

https://youtu.be/KfVzZpnK_M0

Ladd Keith: Evaluating the Use of Urban Heat Island and Heat Increase Modeling in Land Use and Planning Decision-Making

https://youtu.be/0sg43EZ97Zk

Ben McMahan: Visualization and Analysis Tools for the North American Monsoon - Integrating Citizen Science Data and Observations

https://youtu.be/gG_kdCRwCts