Contributors

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

Mike Crimmins
UA Extension Specialist

Dave Dubois
New Mexico State Climatologist

Gregg Garfin
Founding Editor and Deputy Director of Outreach, Institute of the Environment

Nancy J. Selover
Arizona State Climatologist

Published by the Climate Assessment for the Southwest (CLIMAS), with support from University of Arizona Cooperative Extension, the Arizona State Climate Office, and the New Mexico State Climate office.

August Southwest Climate Outlook

Monthly Precipitation and Temperature: July precipitation was mostly below average to much below average in Arizona, while New Mexico ranged from above average to much below average (Fig. 1a). July temperatures were mostly above average to much above average in Arizona and New Mexico, with a small pocket of record warmest in southwestern New Mexico (Fig. 1b). The daily average temperature anomalies for Jul 1 – Aug 15 (Fig. 2) highlight the fluctuations at select stations around the region.

Seasonal Precipitation and Temperature: Total precipitation for the last three months (May-July) was below normal or much below normal for most of Arizona and New Mexico (Fig. 3), and limited early season tropical storms and a late monsoon onset are part of this story. Water year precipitation to date reveals the extent to which much of the Southwest has recorded above average precipitation over the last year, with parts of New Mexico and Colorado as the only areas without normal to above normal precipitation (Fig. 4).

Drought: Despite the recent below average precipitation, the impact of longer-term above average precipitation in much of the Southwest is reflected in the Aug 6 U.S. Drought Monitor (USDM), which continues to document relatively low levels of drought designation in Arizona and New Mexico (Fig. 5). The past three months of mostly below average precipitation, and the late onset of the monsoon, however, will lead drought experts to closely monitor these conditions.

Water Supply: Most of the reservoirs in the region are at or above the values recorded at this time last year, but most also remain below their long-term average (see reservoir storage on p. 7). This illustrates improvements in drought conditions over the past year, but also highlights accumulated water resource deficits linked to multiple years of drought.

Wildfire, Health, and Safety: Despite a late and somewhat sporadic onset of monsoon activity, the resulting precipitation and increased humidity has helped tamp down elevated wildfire risk in much of the Southwest. The National Interagency Fire Center outlooks for August and September each call for average fire risk across the region. In terms of wildfire acres burned, lightning and human caused fires are above median in Arizona, and below median in New Mexico (Fig. 6).

El Niño Tracker: Despite hints (or hope) that this El Niño event might last into early 2020, conditions have returned to ENSO-neutral and are likely to remain neutral through the rest of 2019 and into 2020 (see ENSO-tracker on p. 3 for details).

Precipitation and Temperature Forecast: The three-month outlook for September through November calls for increased chances of above-normal precipitation in parts of New Mexico, 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 August 2019 SW Climate Outlook

CLICK TO TWEET

AUG2019 @CLIMAS_UA SW Climate Outlook, The End of El Niño, Monsoon Tracker, AZ & NM Reservoir volumes, bit.ly/2TyvxKI #SWclimate #AZWX #NMWX

ARIZONA · CLIMAS Climate Assessment for the Southwest, A NOAA RISA TEAM · THE UNIVERSITY OF ARIZONA College of Agriculture & Life Sciences Cooperative Extension · NM STATE UNIVERSITY · NIDIS

August 2019 SW Climate Outlook

Online Resources

Figure 1
National Centers for Environmental Information
ncei.noaa.gov

Figures 2,6
Climate Assessment for the Southwest
climas.arizona.edu

Figures 3,4
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

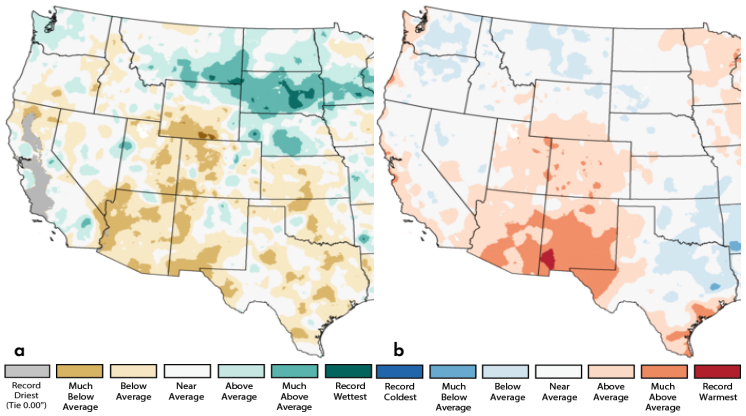


Figure 1: July 2019 Precipitation (a) & Temperature Ranks (b)

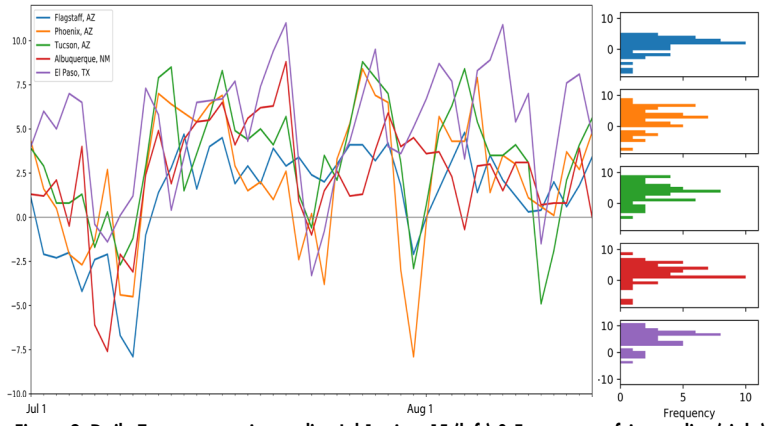


Figure 2: Daily Temperature Anomalies Jul 1 - Aug 15 (left) & Frequency of Anomalies (right)

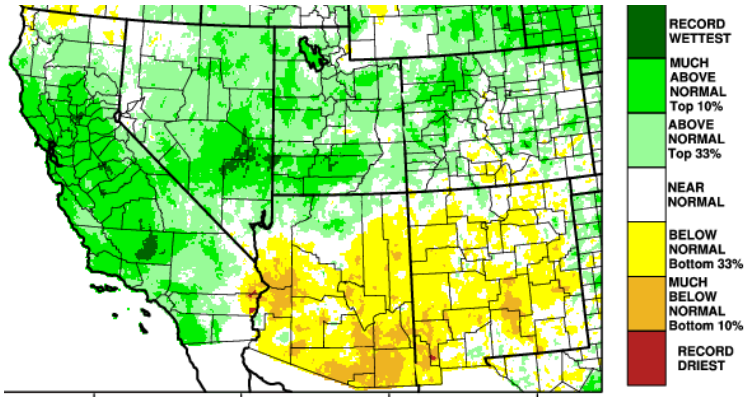


Figure 3: May - July 2019 - Precipitation Percentile Ranking

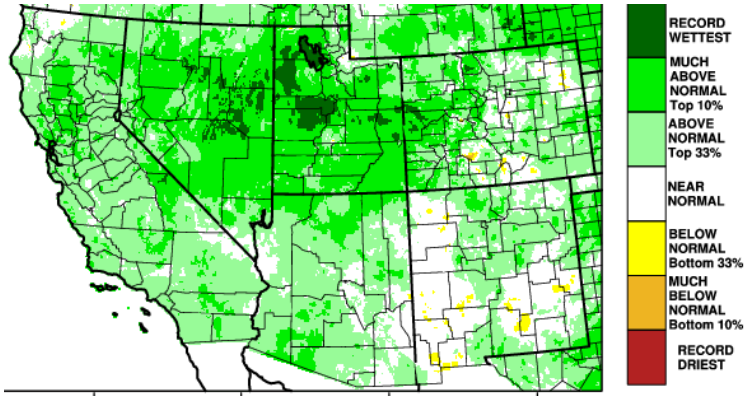


Figure 4: Oct 2018 - July 2019 - Precipitation Percentile Ranking

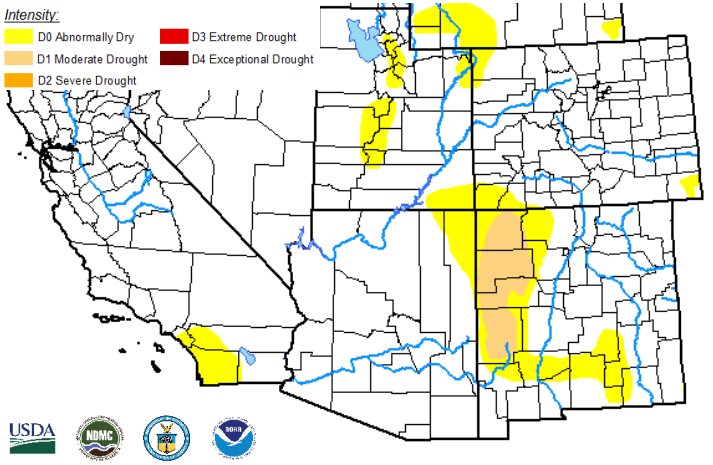


Figure 5: US Drought Monitor - Aug 6, 2019

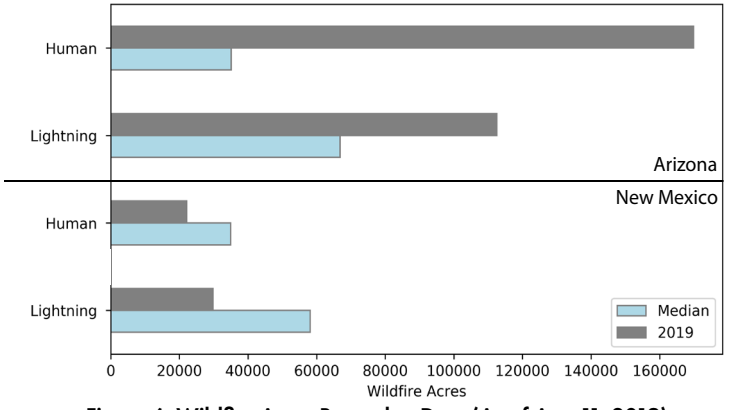


Figure 6: Wildfire Acres Burned to Date (As of Aug 11, 2019)

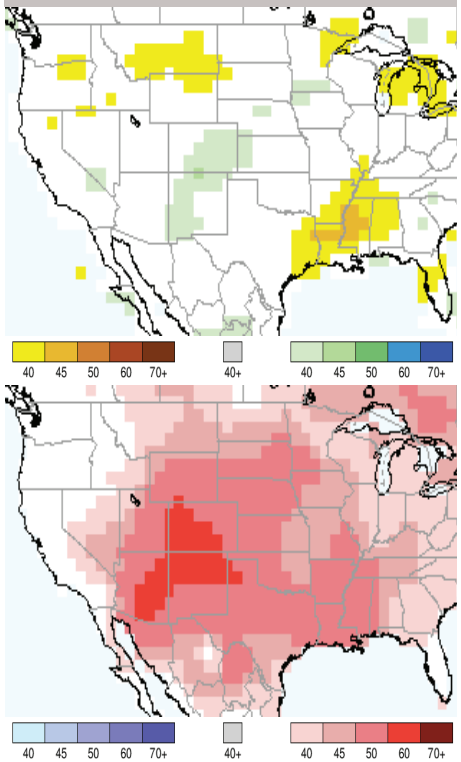


Figure 7: Three-Month (SON) Forecast for Precipitation (top) and Temperature (bottom)

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

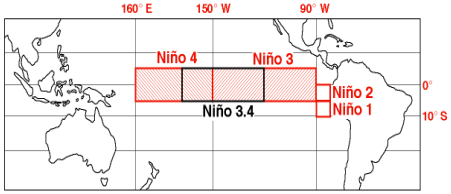
Figure 4
NOAA - Climate Prediction Center
cpc.ncep.noaa.gov

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 based on sea surface temperature (SST) anomalies (Figs. 1-2) and other oceanic and atmospheric indicators have all identified the end of this El Niño event. On Aug 6, the Australian Bureau of Meteorology maintained their ENSO Outlook at 'inactive', stating that "all climate models indicate the tropical Pacific is likely to remain ENSO-neutral for the rest of 2019". On Aug 8, the NOAA Climate Prediction Center (CPC) issued their final El Niño advisory, which reflects the end of oceanic and atmospheric conditions indicative of El Niño. They called for a 50-55% chance of ENSO-neutral conditions persisting through winter 2019-2020. On Aug 8, the International Research Institute (IRI) issued an ENSO Quick Look (Fig. 3), confirming the end of El Niño as SSTs returned to normal in July. Their models see ENSO-neutral as the most likely outcome, but with "higher chances for El Niño than La Niña". On Aug 9, the Japanese Meteorological Agency (JMA) highlighted a return to normal SSTs and other atmospheric indicators and maintained their call for a 60-percent chance of ENSO-neutral conditions to continue until winter 2019. The North American Multi-Model Ensemble (NMME) is within the range of ENSO-neutral and is forecast to remain there through 2019 and into 2020 (Fig. 4).

Summary: As predicted in more recent model runs, oceanic and atmospheric conditions have returned to within the range of normal, and this El Niño event is officially over. This is in spite of earlier outlooks that were rather bullish on El Niño lasting into fall and winter of this year, and it will be interesting to track how forecasters make sense of this relatively quick swing in forecasts in the next month or so. In terms of the Southwest, 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. With a return to ENSO-neutral, the role that El Niño might play in enhancing those pacific tropical storms is much less relevant, and this has been a quiet tropical storm season so far (at least in terms of southwestern impacts). This does not mean there is an increased chance of drier than normal conditions, but it does mean that the enhanced tropial storm activity associated with El Niño is no longer in play.

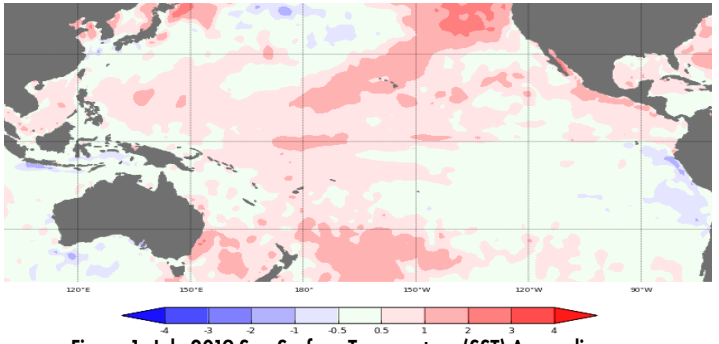


Figure 1: July 2019 Sea Surface Temperature (SST) Anomalies

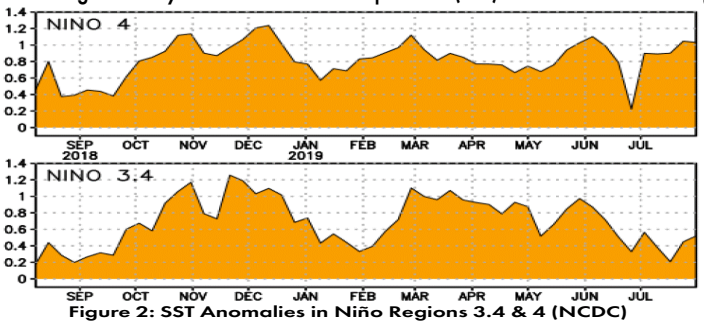


Figure 2: SST Anomalies in Niño Regions 3.4 & 4 (NCDC)

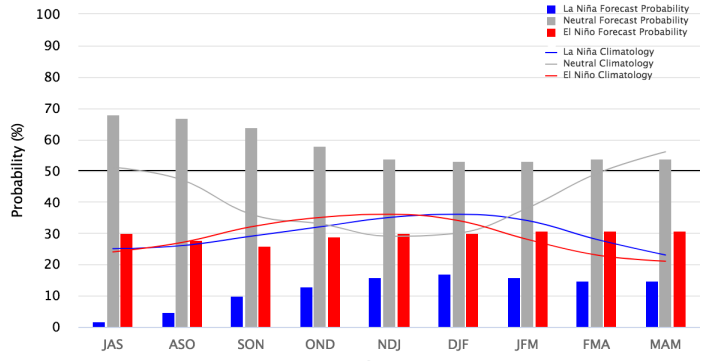


Figure 3: Early-Aug IRI/CPC Model-Based Probabilistic ENSO Forecast

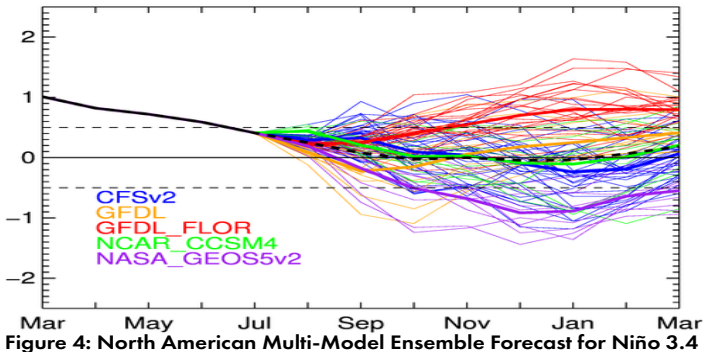


Figure 4: North American Multi-Model Ensemble Forecast for Niño 3.4

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?

Aug 2019 - Monsoon MiniPod - Rogue Storm Late Start Edition

In the this "mini" episode - Mike Crimmins and Zack Guido deconstruct the relative lack of monsoon activity across much of the region, as well as a few places that are receiving more precipitation than expected. They recap some of the totals through Aug 7 and dive into the mechanics that have been driving this (relative lack of) activity. They also check the 1-2 week forecasts to see whether there is any hope for recovery in the latter half of the monsoon.
climas.arizona.edu/media/podcasts

Monsoon Tracker

Given the spatial variability of the monsoon, single weather stations are an imperfect measure, but 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-August. 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.

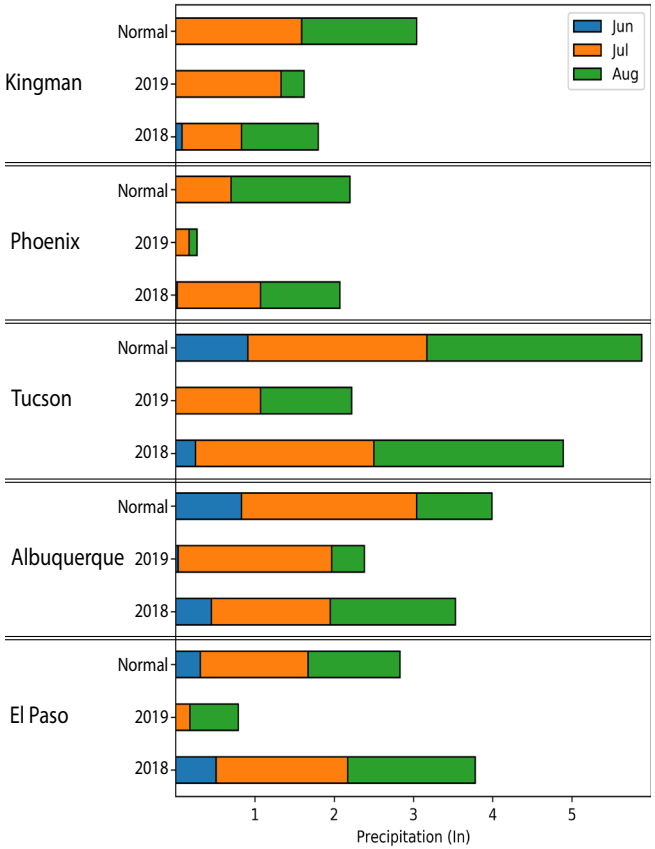


Figure 1: Monthly Monsoon Precipitation Totals - 2018, 2019 & Average

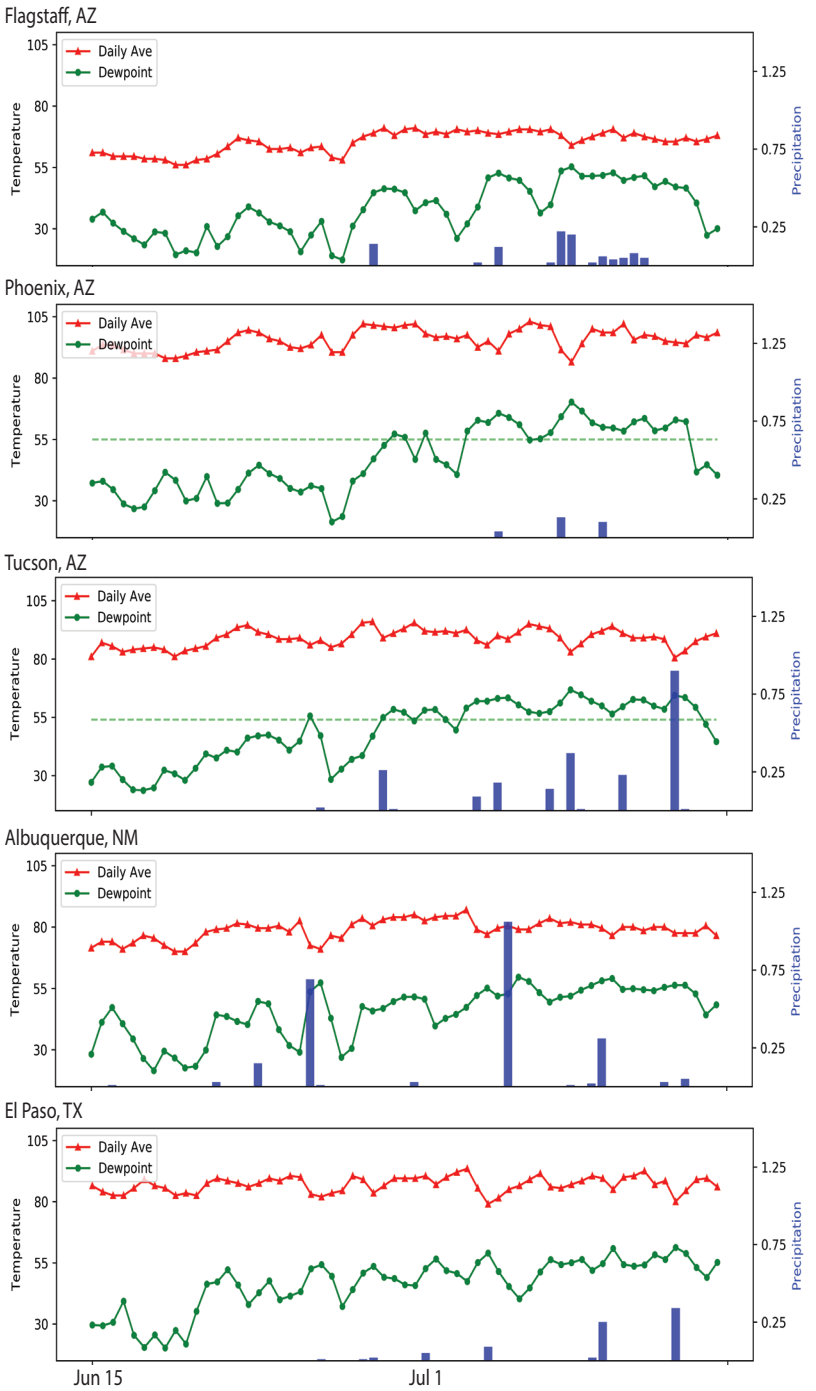


Figure 2: Dew Point and Daily Average Temperature, Daily Precipitation - Jun 15 - Aug 14, 2019

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 variable precipitation in the Southwest, with much of the region lagging behind average accumulated precipitation through mid-July (Fig. 4). Percent of days with rain highlight areas with more regular rainfall events (Fig. 5). Mid-August is the approximate monsoon midpoint*, so there is time for below average areas to catch up, since a relatively late start does not necessarily mean decreased activity over the entire monsoon.

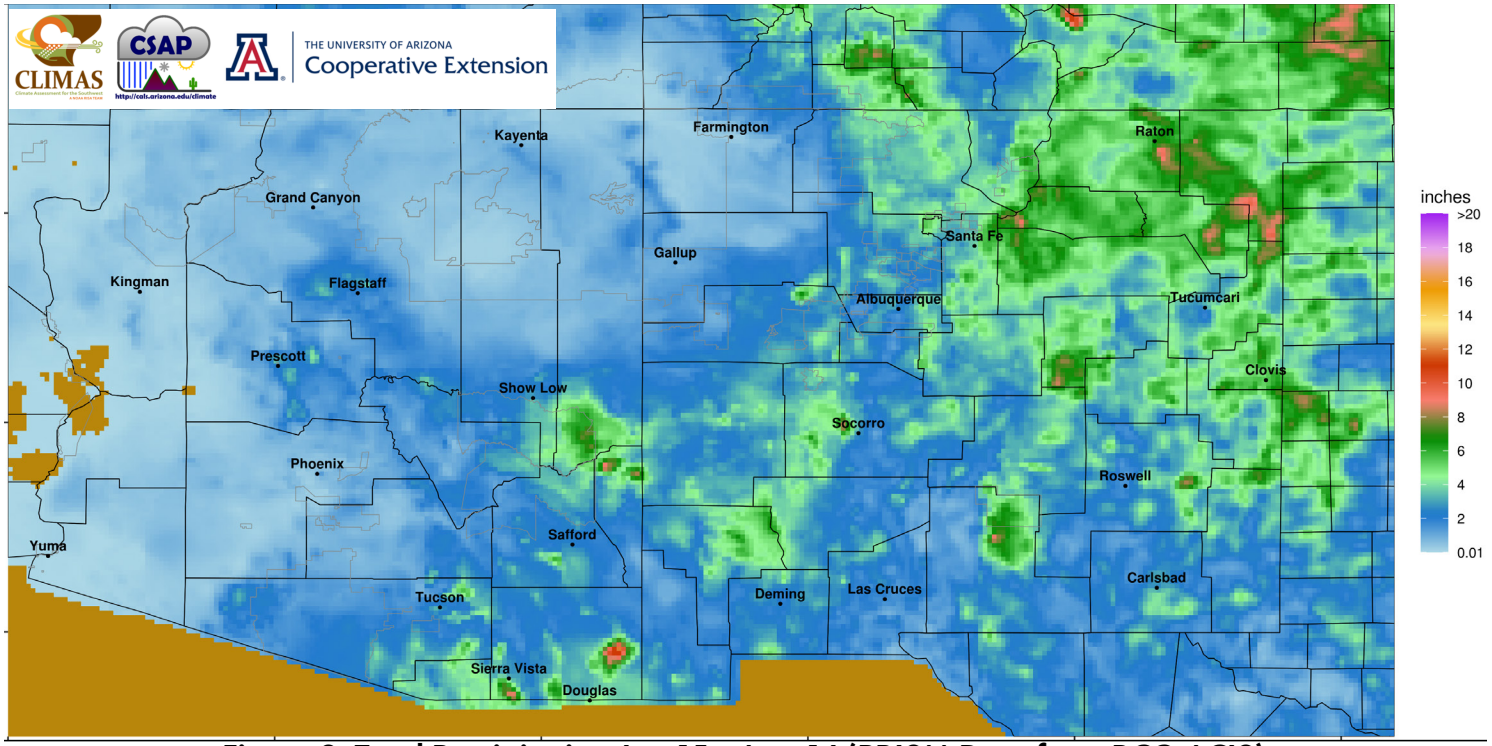


Figure 3: Total Precipitation Jun 15 - Aug 14 (PRISM Data from RCC-ACIS)

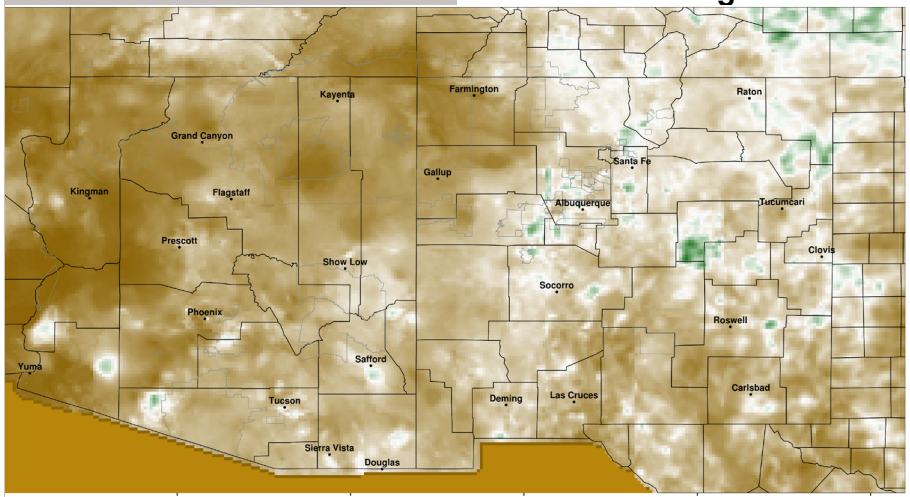


Figure 4: Precipitation percent of Normal Jun 15 - Aug 14 (PRISM Data from RCC-ACIS)

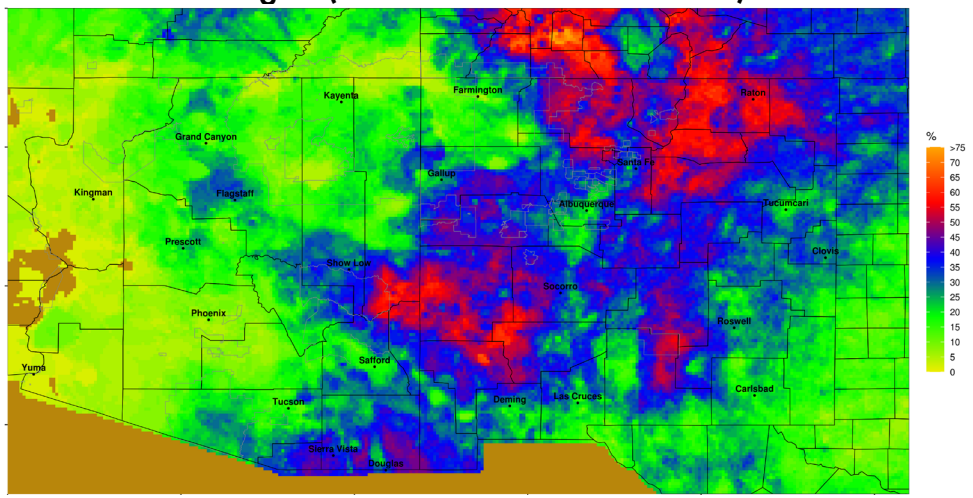


Figure 5: Percent of days with rain Jun 15 - Aug 14 (PRISM Data from RCC-ACIS)

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).

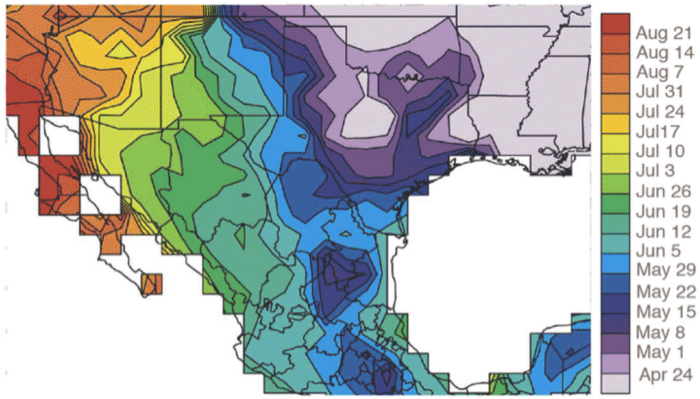


Figure 1: Historical Monsoon Onset Date

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).

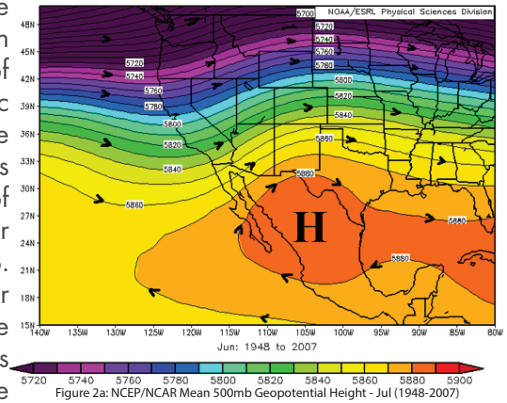


Figure 2a: NCEP/NCAR Mean 500mb Geopotential Height - Jul (1948-2007)

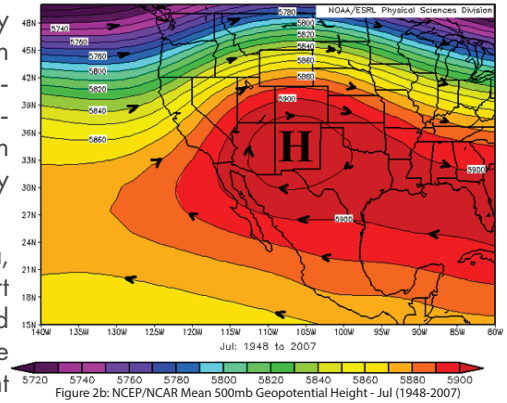


Figure 2b: NCEP/NCAR Mean 500mb Geopotential Height - Jul (1948-2007)

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).

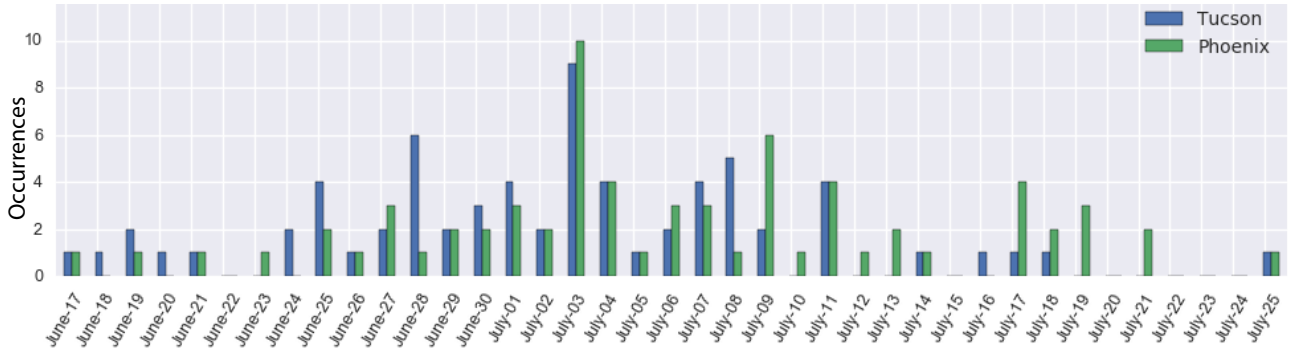


Figure 3: Monsoon Onset (as defined by dewpoint thresholds) in Tucson and Phoenix, Frequency by Date (1949-2016)

Online Resources

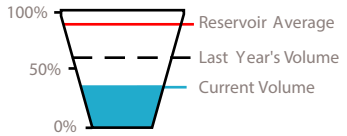
Portions of the information provided in this figure is available at the Natural Resources Conservation Service
www.wcc.nrcs.usda.gov/BOR/basin.html

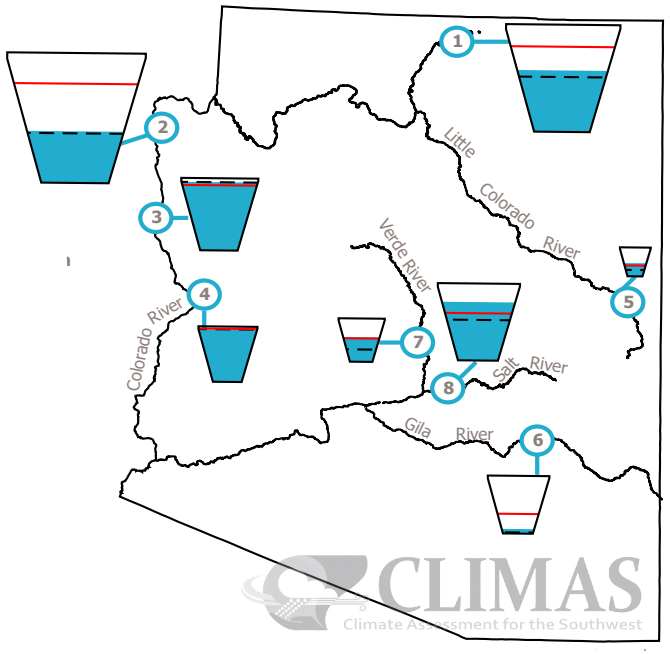
Contact Ben McMahan with questions/comments.

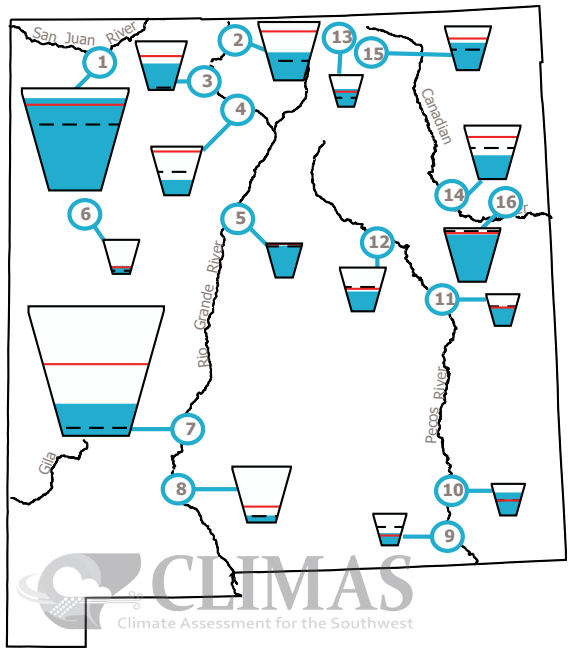
Reservoir Volumes

DATA THROUGH AUG 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	57%	13,933.5	24,322.0	1019.1
2. Lake Mead	39%	10,245.0	26,159.0	-160.0
3. Lake Mohave	95%	1,711.0	1,810.0	13.0
4. Lake Havasu	94%	584.9	619.0	-6.6
5. Lyman	45%	13.4	30.0	-1.8
6. San Carlos	7%	59.3	875.0	-38.0
7. Verde River System	56%	161.5	287.4	-19.5
8. Salt River System	75%	1,528.5	2,025.8	-65.2

*KAF: thousands of acre-feet

Reservoir	Capacity	Current Storage*	Max Storage*	One-Month Change in Storage*
1. Navajo	90%	1530.6	1,696.0	30.0
2. Heron	48%	193.1	400.0	23.5
3. El Vado	54%	102.7	190.3	-10.8
4. Abiquiu	31%	58.1	186.8	-3.5
5. Cochiti	93%	46.6	50.0	0.3
6. Bluewater	23%	8.7	38.5	-1.0
7. Elephant Butte	25%	543.2	2,195.0	-8.1
8. Caballo	12%	41.4	332.0	-6.3
9. Lake Avalon	38%	1.7	4.5	0.0
10. Brantley	73%	30.8	42.2	5.5
11. Sumner	60%	21.7	35.9	-2.6
12. Santa Rosa	45%	47.5	105.9	-23.6
13. Costilla	56%	8.9	16.0	-2.2
14. Conchas	44%	110.8	254.2	-15.8
15. Eagle Nest	63%	50.0	79.0	-1.0
16. Ute Reservoir	88%	175	200	-3.0

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).

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

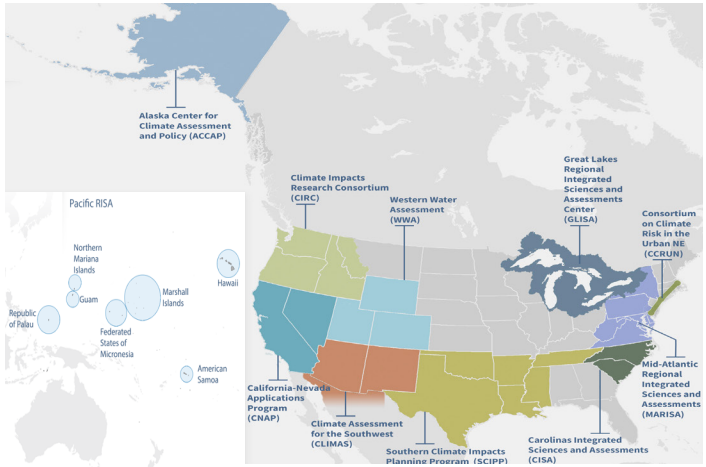


Figure 1: NOAA Regional Integrated Sciences and Assessments Regions

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/WIou8gsOSJQ

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