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June Southwest Climate Outlook

May Precipitation and Temperature: May precipitation was mostly above average to record wettest in Arizona, and New Mexico ranged from below average to much above average but most of the state was average or above-average (Fig. 1a). May temperatures were below average or much below average across most of the Southwest (Fig. 1b).

Seasonal Precipitation and Temperature: Spring precipitation (Mar-Apr-May) was average to above average across most of Arizona and New Mexico (Fig 2a). Temperatures for the same period were mostly average in Arizona and mostly average to above average in New Mexico (Fig. 2b).

Drought: Water year precipitation highlights the wet conditions since Oct. 1, which have led to above normal (top 33%) for a vast majority of the Southwest, along with much above normal (top 10%) and smaller pockets of record wettest in Utah, Nevada, and Colorado (Fig. 3). The Jun. 11 U.S. Drought Monitor (USDM) continues to show improvements in regional drought conditions in the Southwest with Arizona nearly clear of drought designations, and the intensity of drought characterizations in the four corners region and northern New Mexico further reduced compared to last month (Fig. 4).

Snowpack & Water Supply: Late season snowpack and snow water equivalent (SWE) measurements are all but absent in Arizona and New Mexico this time of year, while upper elevation areas in Utah and Colorado that feed into reservoirs are mostly over 200-percent of average (Fig. 5, see Snow Water Equivalent recap on p. 5).

Wildfire, Health, and Safety: May weather conditions (including wetter than average precipitation, mild temperatures, and elevated relative humidity), helped tamp down fire risk in May and into June. Wildfire outlooks for July identify above normal fire risk in lower elevation regions (Fig. 6), linked to widespread fine fuel growth driven by above-average precipitation across the cool season.

El Niño Tracker: Atmospheric and oceanic conditions remain in line with a weak El Niño, and most forecasts call for this event to last at least through summer, and possibly longer (see El Niño tracker on p. 3 for more details).

Precipitation and Temperature Forecast: The three-month outlook for July through September calls for increased chances of below-normal precipitation in eastern Arizona, western New Mexico, and the four corners region, with equal chances of above- or below-normal precipitation in much of the rest of Arizona, New Mexico, west Texas, and northern Mexico (Fig. 7, top). The three-month outlook calls for increased chances of above-normal temperatures in Arizona, and parts of northern New Mexico and northern Mexico (Fig. 7, bottom).

Tweet June 2019 SW Climate Outlook

CLICK TO TWEET

JUN2019 @CLIMAS_UA SW Climate Outlook, El Niño, SnowWater Recap, Monsoon Preseason, AZ & NM Reservoir volumes, CLIMAS colloquium videos, bit.ly/2FnNmqh #SWclimate #AZWX #NMWX

Online Resources

Figures 1-2
National Centers for Environmental Information
ncei.noaa.gov

Figures 3,5
Western Regional Climate Center
wrcc.dri.edu

Figure 4
U.S. Drought Monitor
droughtmonitor.unl.edu

Figure 6
National Interagency Fire Center
nifc.gov

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

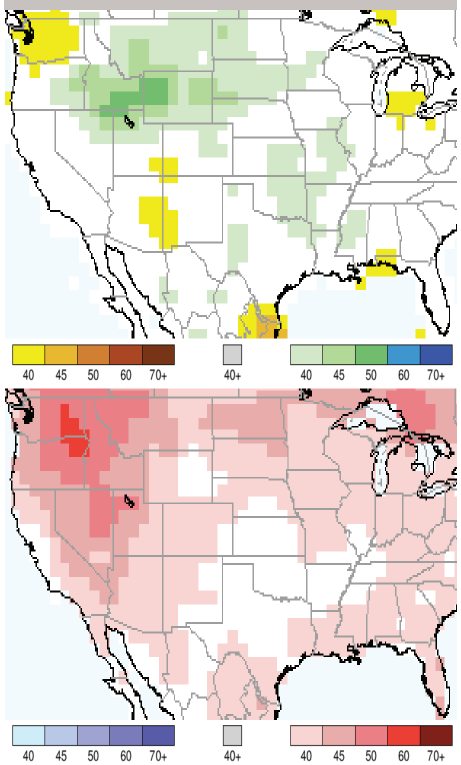


Figure 7: Three-Month (JAS) Forecast for Precipitation (top) and Temperature (bottom)

June 2019 SW Climate Outlook

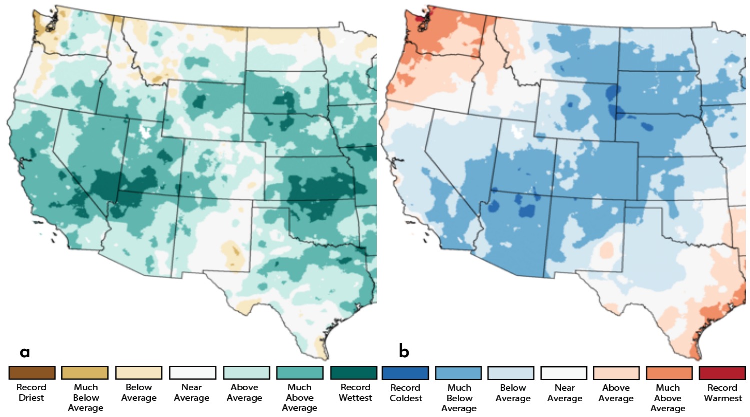


Figure 1: May 2019 Precipitation (a) & Temperature Ranks (b)

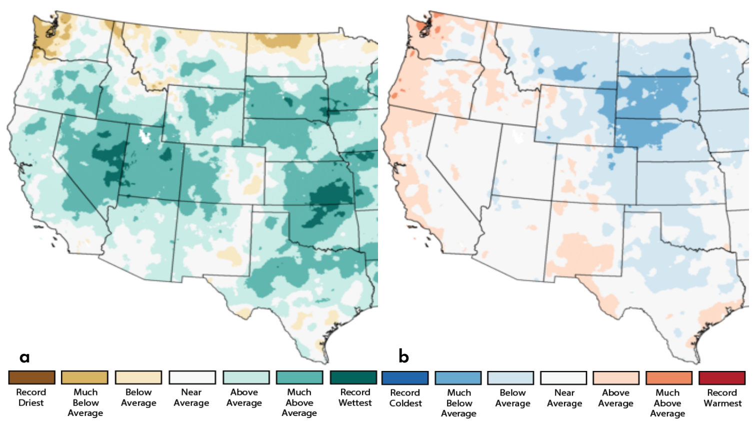


Figure 2: Mar - May 2019 Precipitation (a) & Temperature Ranks (b)

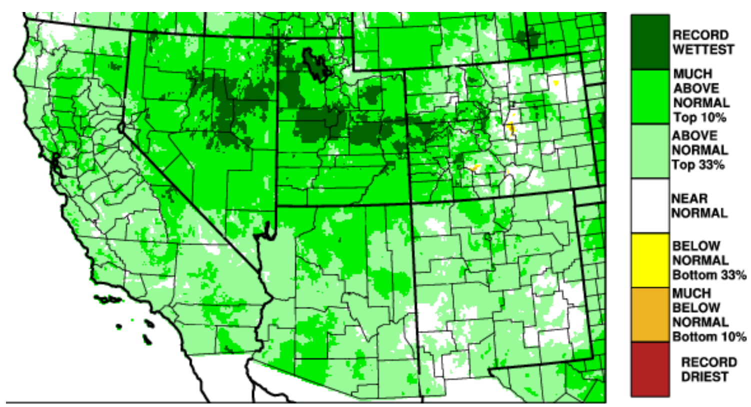


Figure 3: Oct 2018 - May 2019 - Precipitation Rankings

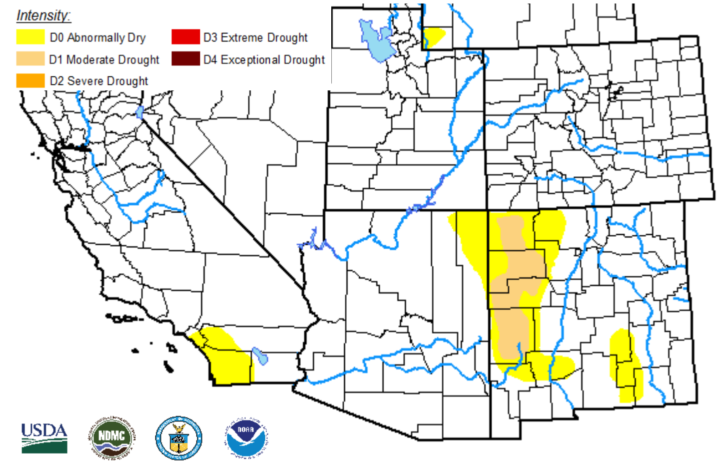


Figure 4: US Drought Monitor - Jun 11, 2019

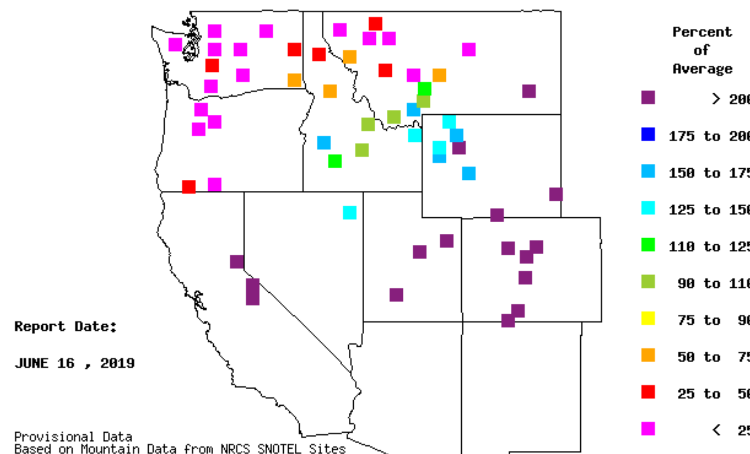


Figure 5: Snow Water Equivalent (SWE) - Jun 16, 2019

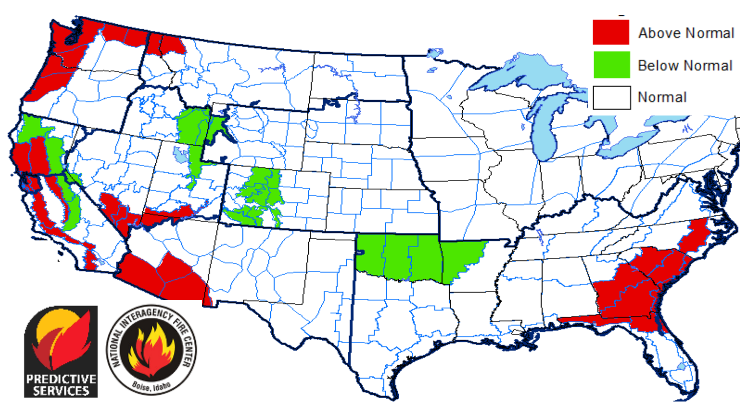


Figure 6: Significant Wildland Fire Potenatial July 2019

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

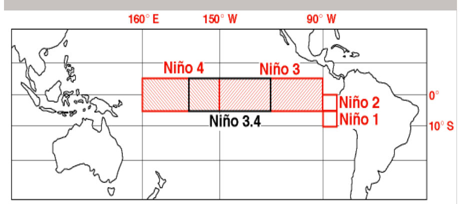
Figure 4
NOAA - Climate Prediction Center
cpc.ncep.noaa.gov

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 are based on the persistence of sea surface temperature (SST) anomalies consistent with a weak El Niño event (Figs. 1-2), along with the presence of other atmospheric and oceanic indicators (convective anomalies, sub-surface temperatures). On June 10, the Japanese Meteorological Agency (JMA) noted persistent SST anomalies along with atmospheric and sub-surface indicators of El Niño, and called for a 70-percent chance of these conditions continuing into summer, and a 60-percent chance to last into fall. On June 11, the Australian Bureau of Meteorology maintained their ENSO Outlook at watch status, calling for a 50-percent chance of an El Niño event in 2019. On June 13, the NOAA Climate Prediction Center (CPC) maintained their El Niño advisory based on the SST anomalies, along with convective anomalies and sub-surface temperatures. Their outlook dipped to a 66-percent chance of El Niño lasting through summer, and 50- to 55-percent of lasting through fall. On June 19, the International Research Institute (IRI) issued an ENSO Quick Look (Fig. 3), highlighting above-average SSTs and warm subsurface waters, and "some" atmospheric indicators consistent with El Niño. The North American Multi-Model Ensemble (NMME) points toward a weak El Niño lasting into fall 2019 (Fig. 4), with considerable spread based on uncertainty.

Summary: El Niño conditions are within the range of a weak event. Based on current models and forecasts, the likely trajectory is for these conditions to persist through summer, with increasing uncertainty and model spread heading into fall and winter. As reported last month, there are two associations of note. The first is enhanced northern pacific tropical storm activity, which could see tropical storms increase our warm season precipitation totals in direct ways (i.e. storms that push into the region) or that provide additional moisture and instability that enhances monsoon activity. This is more commonly seen during the latter half of the monsoon into Fall, and unlike last year with TS Bud, there has not been early season tropical storm activity that pushed moisture into the Southwest. The second association is tenuous given small sample sizes, but El Niño conditions over summer have been linked to a delayed onset of monsoon activity. This linkage appears to be influencing some seasonal forecasts and has been picked up in the media, but the science and our understanding of this link is still evolving. Big picture? El Niño sends mixed signals for seasonal outlooks and will keep us guessing regarding the timing and intensity of tropical storm activity and monsoon precipitation – in other words, a typical summer in the Southwest.

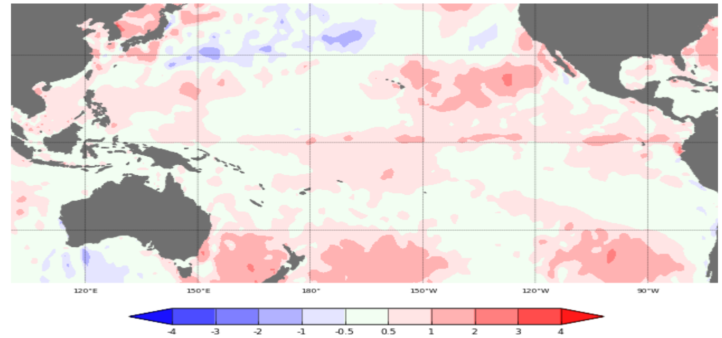


Figure 1: May 2019 Sea Surface Temperature (SST) Anomalies

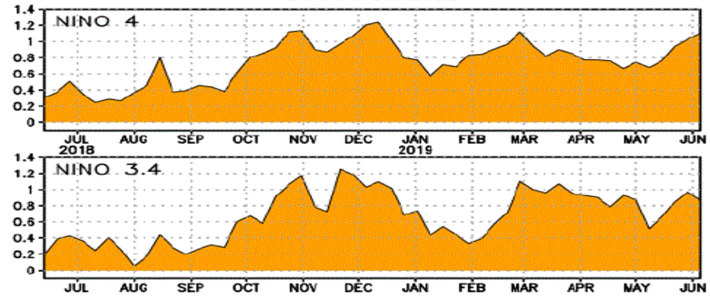


Figure 2: SST Anomalies in Niño Regions 3.4 & 4 (NCDC)

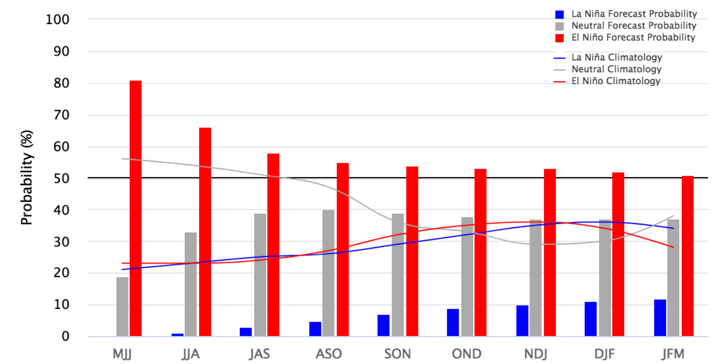


Figure 3: Early-June IRI/CPC Model-Based Probabilistic ENSO Forecast

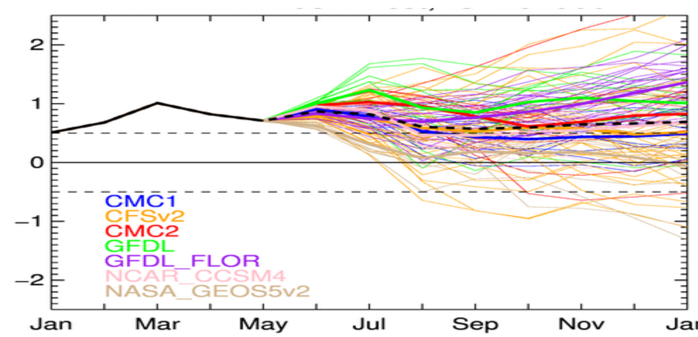


Figure 4: North American Multi-Model Ensemble Forecast for Niño 3.4

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).

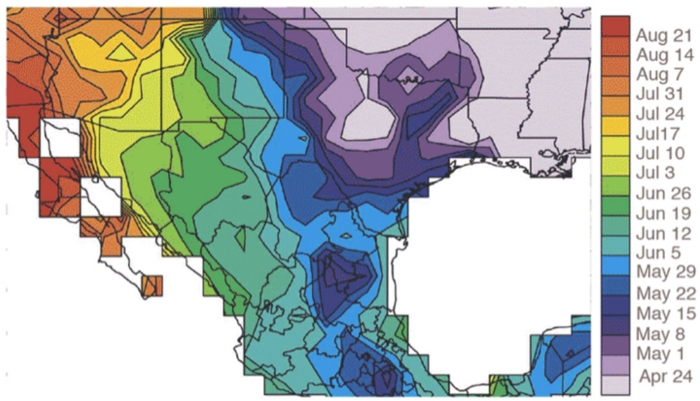


Figure 1: Historical Monsoon Onset Date

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).

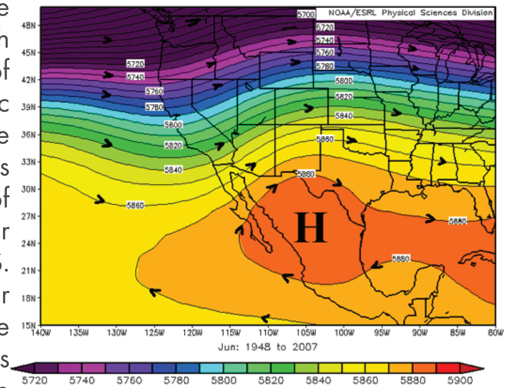


Figure 2a: NCEP/NCAR Mean 500mb Geopotential Height - Jul (1948-2007)

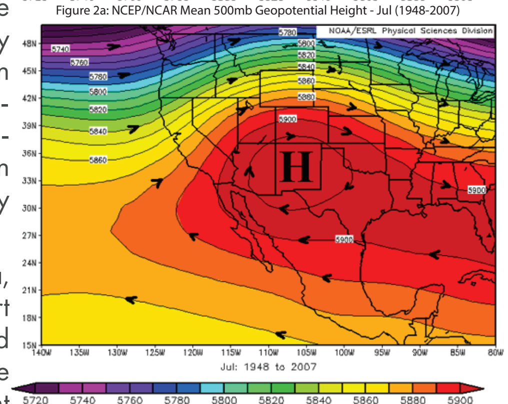


Figure 2b: NCEP/NCAR Mean 500mb Geopotential Height - Jul (1948-2007)

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).

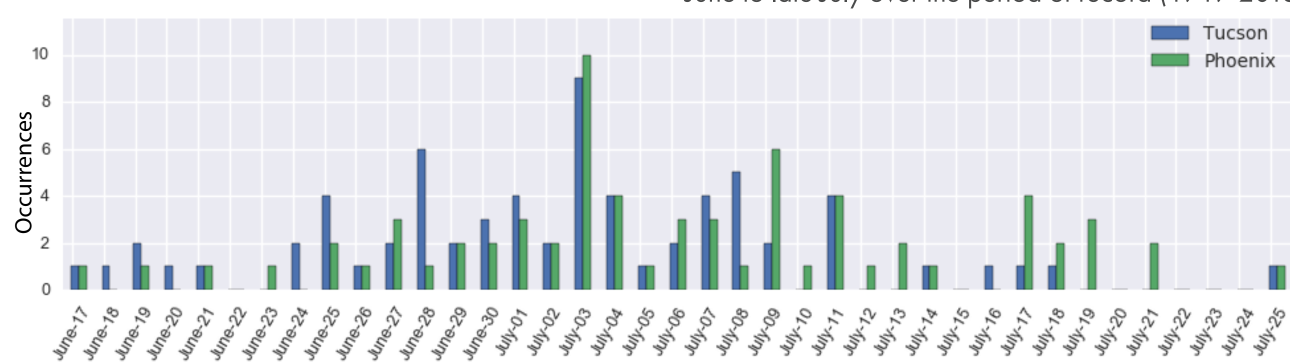


Figure 3: Monsoon Onset (as defined by dewpoint thresholds) in Tucson and Phoenix, Frequency by Date (1949-2016)

Online Resources

Figure 1
Western Regional Climate Center
wrcc.dri.edu

Figures 2-7
Natural Resources Conservation Service
nrcs.usda.gov

Snow Water Equivalent Recap

Snow water equivalent (SWE) reveals the extent to which above average precipitation over the cool season (Fig. 1) is reflected across the river basins in the Southwest (Fig. 2). SWE data for the upper elevation regions of the Colorado and Rio Grande Regions (Figs. 3-4) and the lower elevation basins in the Lower Colorado Region (Figs. 5-7) highlight the increase between water year 2019 (Oct 1 2018 - Sep 30 2019) compared to water year 2018 (Oct 1 2017 - Sept 30 2018). This increase is reflected in drought monitoring and reservoir storage numbers.

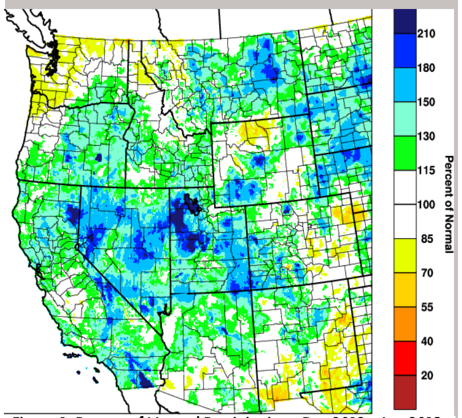


Figure 1: Percent of Normal Precipitation - Dec 2018 - Apr 2019

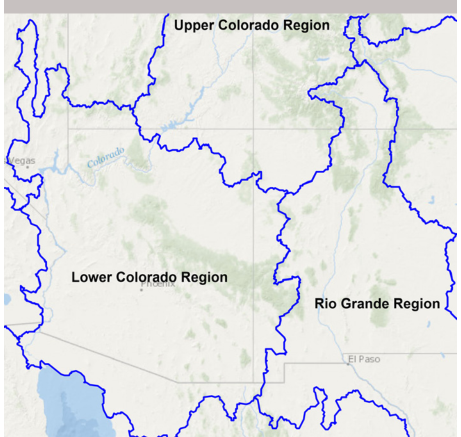


Figure 2: Regional River Basin Boundaries

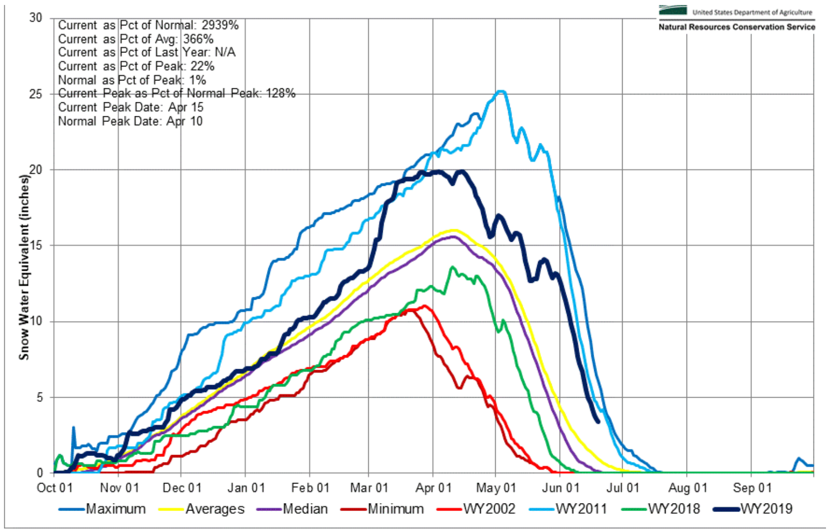


Figure 03: Upper Colorado River Basin Snow Water Equivalent

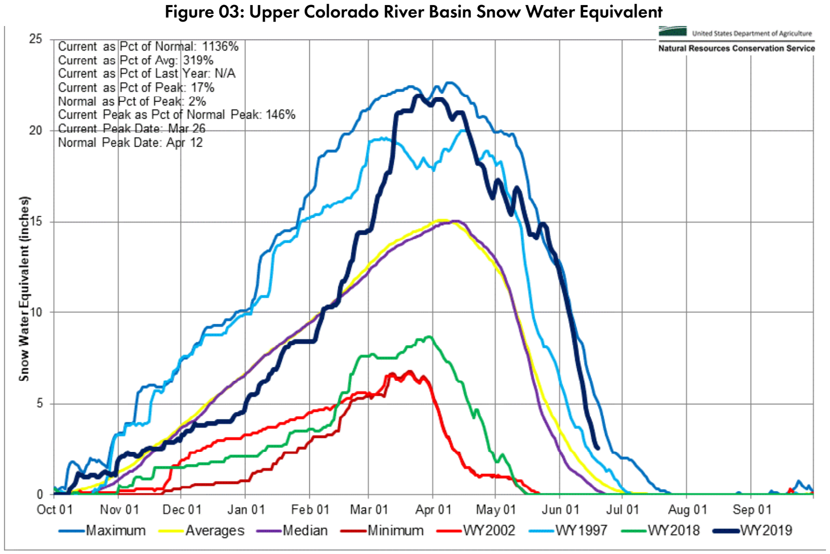


Figure 04: Upper Rio Grande Basin Snow Water Equivalent

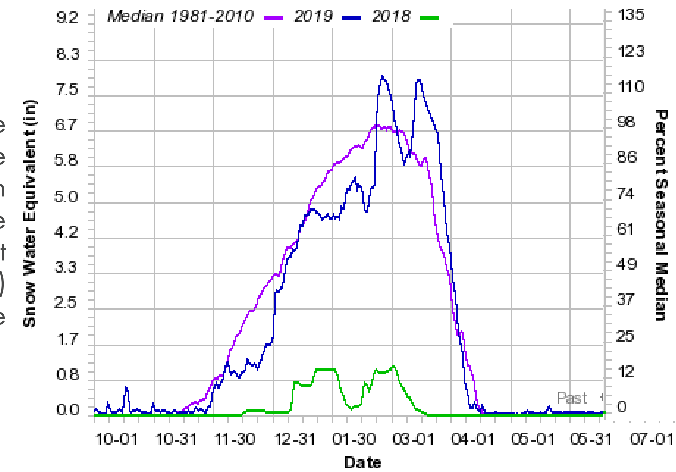


Figure 05: Salt River Basin Snow Water Equivalent

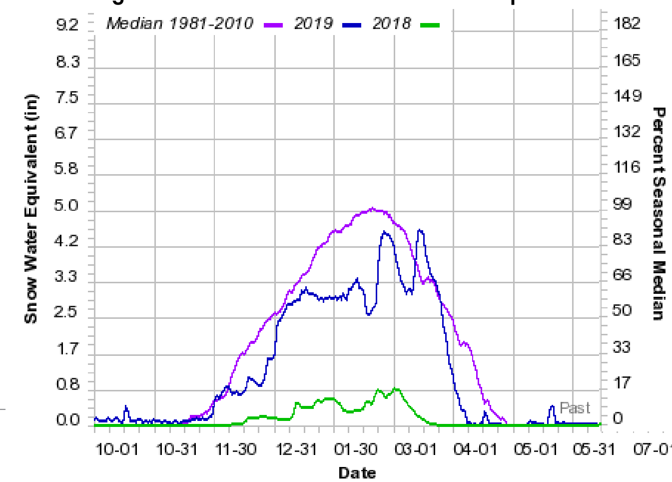


Figure 06: Gila River Basin Snow Water Equivalent

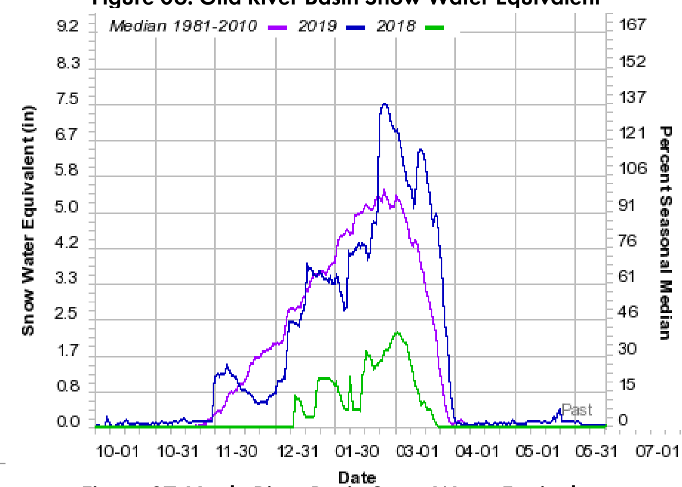


Figure 07: Verde River Basin Snow Water Equivalent

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.

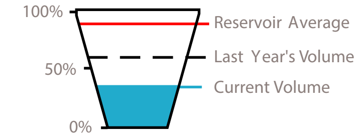
The map gives a representation of current storage for reservoirs in Arizona and New Mexico. Reservoir locations are numbered within the blue circles on the map, corresponding to the reservoirs listed in the table. The cup next to each reservoir shows the current storage (blue fill) as a percent of total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

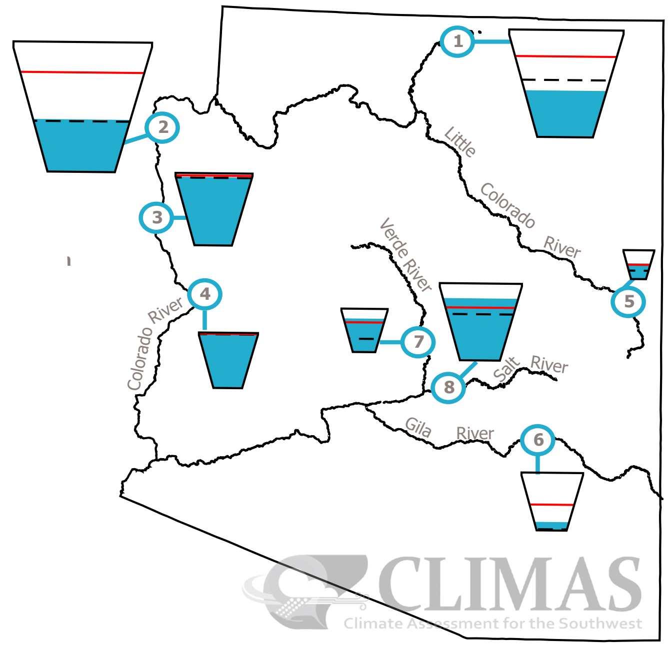
The table details more exactly the current capacity (listed as a percent of maximum storage). Current and maximum storage are given in thousands of acre-feet for each reservoir. One acre-foot is the volume of water sufficient to cover an acre of land to a depth of 1 foot (approximately 325,851 gallons).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

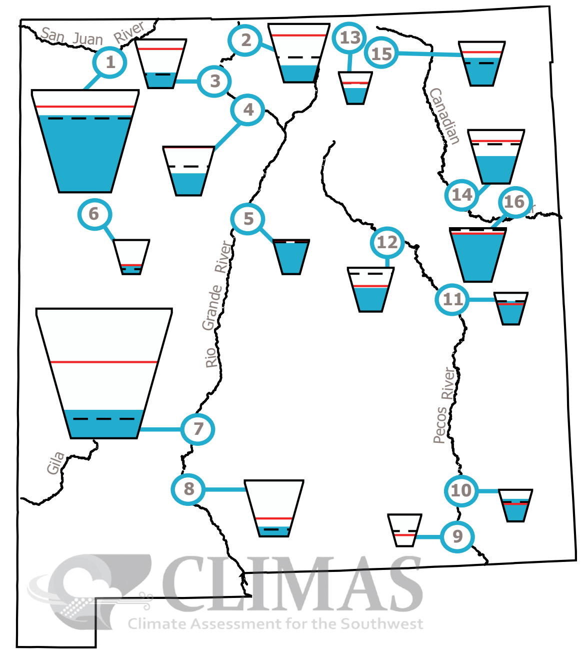
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS).

Reservoir Volumes

DATA THROUGH JUNE 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	43%	10,343.1	24,322.0	1145.2
2. Lake Mead	40%	10,548.0	26,159.0	-219.0
3. Lake Mohave	94%	1,709.0	1,810.0	24.0
4. Lake Havasu	96%	594.1	619.0	25.5
5. Lyman	54%	16.1	30.0	0.0
6. San Carlos	15%	129.5	875.0	-20.5
7. Verde River System	77%	220.2	287.4	-24.0
8. Salt River System	80%	1,617.1	2,025.8	10.5

*KAF: thousands of acre-feet

Reservoir	Capacity	Current Storage*	Max Storage*	One-Month Change in Storage*
1. Navajo	75%	1278.8	1,696.0	161.1
2. Heron	29%	115.7	400.0	34.6
3. El Vado	32%	60.8	190.3	30.2
4. Abiquiu	45%	84.5	186.8	9.3
5. Cochiti	91%	45.7	50.0	-7.8
6. Bluewater	28%	10.9	38.5	-0.8
7. Elephant Butte	22%	486.3	2,195.0	168.4
8. Caballo	17%	55.7	332.0	25.1
9. Lake Avalon	0%	0.0	4.5	-2.3
10. Brantley	71%	29.8	42.2	10.6
11. Sumner	74%	26.7	35.9	-2.5
12. Santa Rosa	54%	57.2	105.9	-17.6
13. Costilla	50%	8.0	16.0	2.8
14. Conchas	51%	130.3	254.2	5.7
15. Eagle Nest	63%	50.1	79.0	7.0
16. Ute Reservoir	91%	181	200	-1.0

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

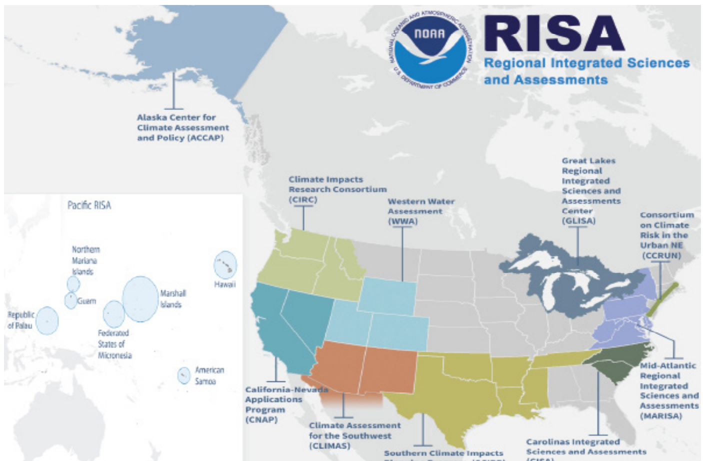


Figure 1: NOAA Regional Integrated Sciences and Assessments Regions

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/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