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November Southwest Climate Outlook

Precipitation and Temperature: October was relatively wet and cool across the Southwest. Precipitation ranged from average to much-above average in New Mexico and from above average to much-above average in Arizona (Fig. 1a). Temperatures were much cooler than normal, ranging from below average to average in Arizona and from below to above average in New Mexico (Fig. 1b). Year-to-date precipitation is highly variable across the region, ranging from record driest in the drought-stricken Four Corners region to much-above average in parts of southern Arizona impacted by heavy tropical storm precipitation (Fig. 2a). Year-to-date temperatures show much less variability, generally much-above average to record warmest throughout the region (Fig. 2b).

Drought: The Nov. 13 U.S. Drought Monitor (USDM) highlights the presence of drought across the entire Southwest, with persistent and severe drought conditions in the Four Corners region (Fig. 3). The USDM reveals the challenge of mapping different timescales and intensities of drought in the Southwest on a weekly basis. In a region already characterized by dry conditions, where accumulated precipitation deficits may build over seasons and years, and where the timing and intensity of precipitation may have a bigger effect than short-term or seasonal totals, these drought characterizations can struggle to capture all of these inputs. The 18-month and 36-month standardized precipitation indices (SPI) for the Southwest (Figs. 4-5, respectively) demonstrate how these different timescales reveal differential patterns of drought and precipitation deficit.

Snowpack & Water Supply: Snow water equivalent across the Southwest is generally below average, although there has been some early-season activity of note in the Upper Colorado River Basin and portions of northern New Mexico (Fig. 6). Reservoir storage remains a persistent concern in terms of long-term drought and accumulated precipitation deficit, with most of the reservoirs at or below their long-term averages, including a few of the Rio Grande reservoirs that are at especially low levels (see reservoir storage on p. 6).

Tropical Storms: The Pacific hurricane season has been very active, with 23 named storms at the time of this writing, including ten major hurricanes (category 4 or above) (see Tropical Storm Recap on p. 4-5). This far surpassed the NOAA forecast of 14-20 named storms and seven major hurricanes. This year also marked the most intense Pacific hurricane season on record, with an Accumulated Cyclonic Energy of 317, breaking the previous record of 295 set in 1992. In addition to the overall intensity, a few notable aspects of this season were the multiple incursions of moisture into the Southwest (Bud, TD 19-E, Rosa, Sergio) and the damaging storms that hit the coast of Mexico (TD 19-E, Vicente, Willa).

El Niño Tracker: This has been an odd year for El Niño. Oceanic indicators are now well into El Niño territory, with warming sea-surface temperatures in the equatorial Pacific, but atmospheric indicators have lagged behind. Most forecasts noted a lack of coupling between ocean and atmosphere but remain confident of an El Niño event during winter 2018-2019, with forecast probabilities hovering around an 80-percent likelihood in most outlooks (see El Niño Tracker on p. 3).

Precipitation and Temperature Forecast: The three-month outlook for December through February calls for increased chances of above-normal precipitation in Arizona and New Mexico (Fig. 7, top), and increased chances of above-average temperatures for the entire western United States (Fig. 7, bottom).

Tweet Nov 2018 SW Climate Outlook

CLICK TO TWEET

NOV2018 @CLIMAS_UA SW Climate Outlook, El Niño Tracker, Tropical Storm Activity in the SW, AZ & NM Reservoir volumes https://bit.ly/2TgROvZ #SWclimate #AZWX #NMWX

November 2018 SW Climate Outlook

Online Resources

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

Figure 3
U.S. Drought Monitor
droughtmonitor.unl.edu

Figures 4-6
Western Regional Climate Center
wrcc.dri.edu

Figure 7
NOAA - Climate Prediction Center
cpc.ncep.noaa.gov

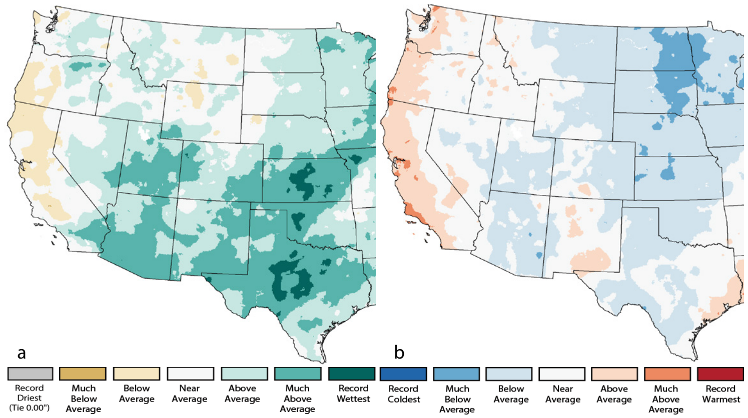


Figure 1: October 2018 Precipitation (a) & Temperature Ranks (b)

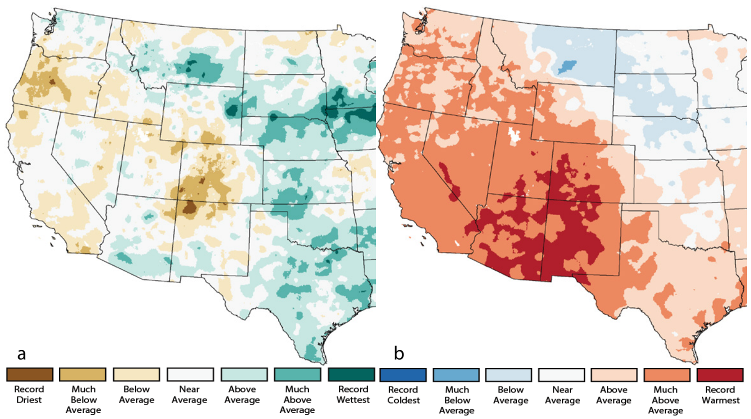


Figure 2: Jan-Oct 2018 Precipitation (a) & Temperature Ranks (b)

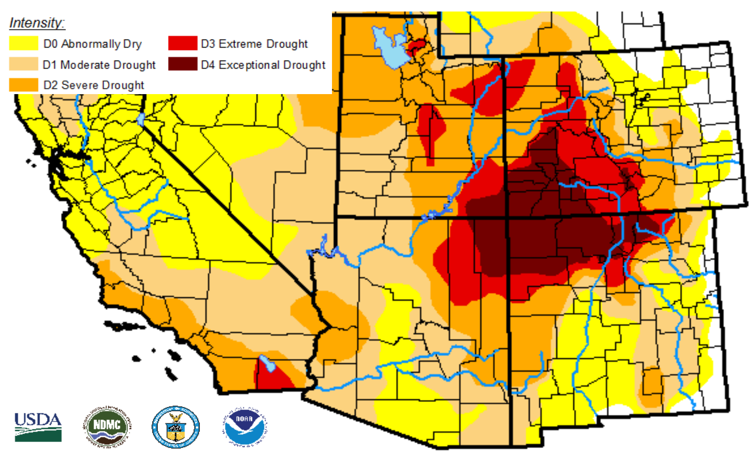


Figure 3: US Drought Monitor - Nov 13, 2018

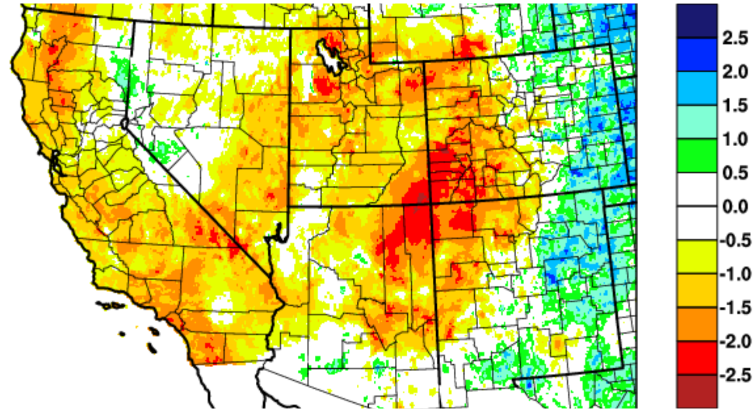


Figure 4: Oct 2018 - 18 Month Standardized Precipitation Index

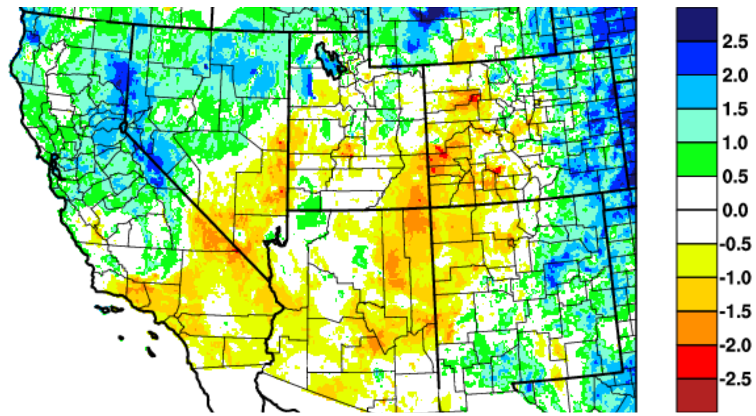


Figure 5: Oct 2018 - 36 Month Standardized Precipitation Index

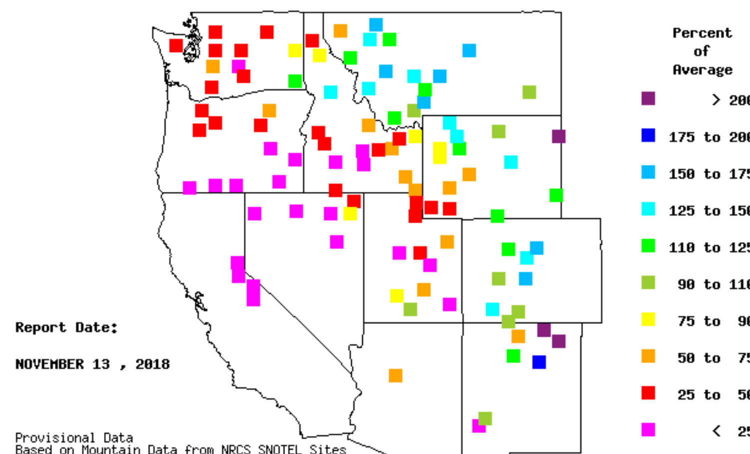


Figure 6: Snow Water Equivalent (SWE) - Nov 13, 2018

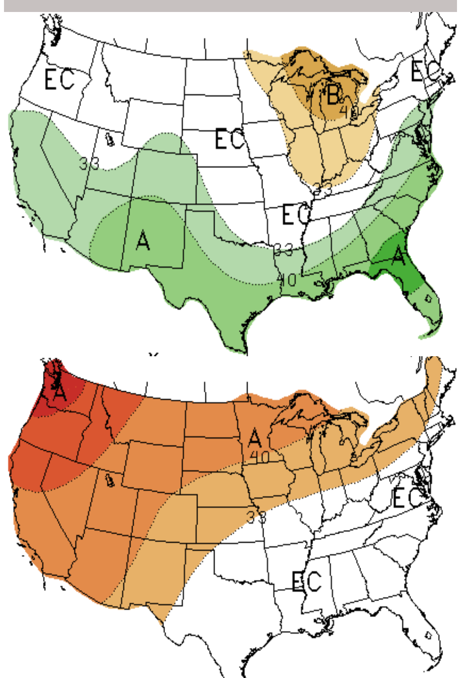


Figure 7: Three-Month Outlook - Precipitation (top) & Temperature (bottom) - Nov 15, 2018

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

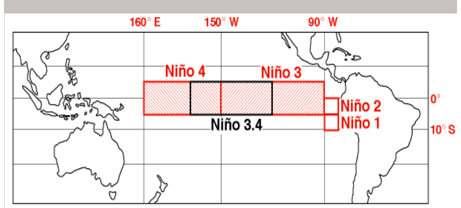
Figure 4
NOAA - Climate Prediction Center
cpc.ncep.noaa.gov

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

Not quite El Niño? Widespread areas of above-average sea-surface temperatures (SSTs) now exist in the equatorial Pacific (Figs. 1-2), but atmospheric conditions have lagged behind. Most forecasts and outlooks, while still bullish on the emergence of an El Niño in 2018, identified current conditions as ENSO-neutral, but see an imminent shift in atmospheric circulations more characteristic of an an El Niño event. On Nov. 7, the Australian Bureau of Meteorology noted persistent above-average oceanic temperatures, but saw the continued presence of atmospheric conditions much closer to normal. The agency noted that coupling between oceanic and atmospheric conditions "is critical in any El Niño developing and becoming self-sustaining." It maintained its ENSO Outlook at an "El Niño Alert," with a 70-percent chance of its formation in 2018. On Nov. 8, the NOAA Climate Prediction Center (CPC) continued its El Niño watch, identifying neutral conditions at present and an 80-percent chance of an El Niño event developing this winter, and a 55- to 60-percent chance of it lasting through spring. CPC also noted the lack of oceanic/atmospheric coupling as hindering the progression of an El Niño event in an otherwise much-warmer-than-average ocean. On Nov. 8, the International Research Institute (IRI) issued an ENSO Quick Look that also reflected the warmer-than-average oceanic temperatures and the lagging atmospheric conditions, and maintained a greater-than-80-percent chance of an El Niño event by the end of 2018 (Fig. 3). Breaking from the other agencies, on Nov. 9, the Japanese Meteorological Agency (JMA) did identify the presence of El Niño conditions in the equatorial Pacific, with a 70-percent chance of these conditions lasting through spring 2019. JMA declared the El Niño despite the absence of atmospheric conditions consistent with such an event, stating that the lagging onset and resulting conditions are "common features of past El Niño events." The North American Multi-Model Ensemble (NMME) points toward a weak-to-moderate El Niño by the end of the year (Fig. 4).

Summary: Equatorial SSTs have been rising and would appear to indicate the onset of an El Niño event except that the atmospheric patterns remain ENSO-neutral. Most outlooks are not particularly concerned about the current lack of oceanic/atmospheric coupling and expect that to occur by year's end—in fact JMA considers the El Niño to have already begun. Further, most forecasts call for this El Niño event to last through spring. Cool-season precipitation totals (Oct – March) in the Southwest during previous El Niño events reveal considerable variability under weak events, including some drier-than-average seasonal totals. However, under moderate-intensity events, drier-than-average cool seasons have been rare, and it is not difficult to understand why there is eager anticipation for anything that might increase our chances of more winter rain.

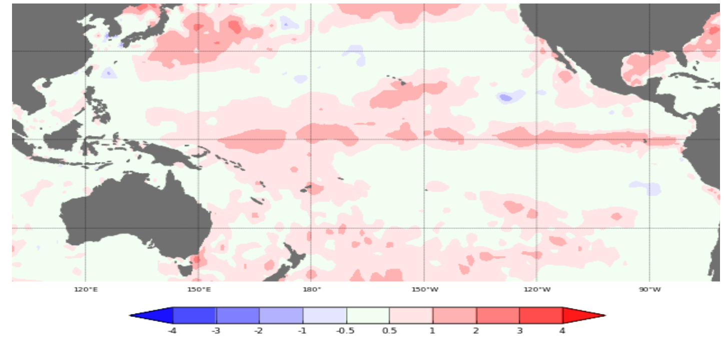


Figure 1: October 2018 Sea Surface Temperature (SST) Anomalies

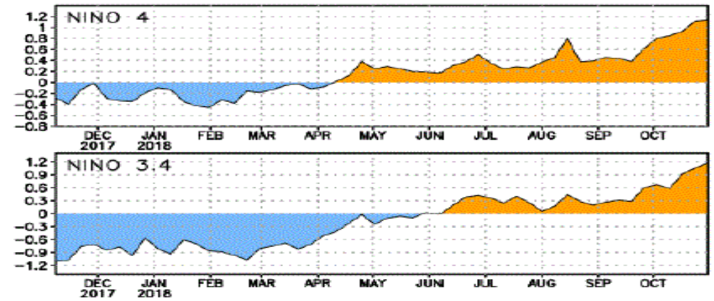


Figure 2: SST Anomalies in Niño Regions 3.4 & 4 (NCDC)

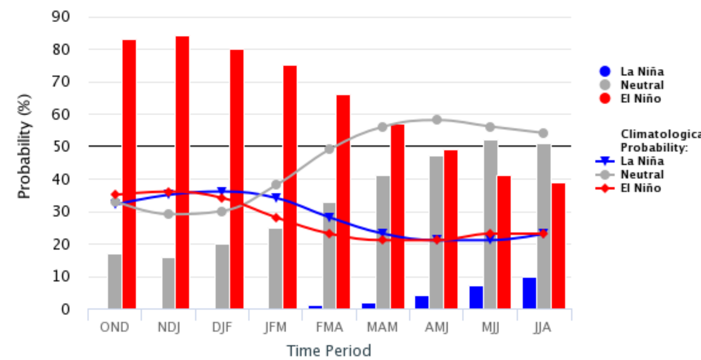


Figure 3: Early-Nov IRI/CPC Model-Based Probabilistic ENSO Forecast

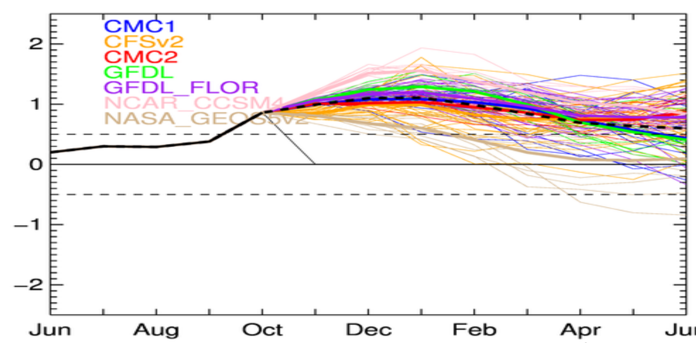


Figure 4: North American Multi-Model Ensemble Forecast for Niño 3.4

Online Resources

Figure 1
Hurricane Tracks
NWS National Hurricane Center
nhc.noaa.gov

Figures 2-3
CLIMAS: Climate Assessment for the Southwest
climas.arizona.edu

Data: prism.nacse.org

**For an extended discussion of TS Bud, the monsoon, and monsoon statistics, check out the Southwest Climate Podcast - CLIMAS's monthly podcast on weather and climate in the Southwest*

climas.arizona.edu/podcasts/climas-southwest-climate-podcast

Tropical Storm Recap

The Pacific hurricane season was very active this year, with 23 named storms, including ten major (category 4 or above) hurricanes (Fig. 1). This year was also the most intense Pacific hurricane season on record, with an Accumulated Cyclonic Energy of 317, breaking the record of 295 set in 1992. In the eastern North Pacific region alone, there were 22 named storms and eight major hurricanes, breaking the previous record of seven.

Many of the early-season storms were active over the Pacific Ocean, while storms later in the season had a few notable impacts on land, including our region. This type of seasonal progression is not unexpected: later-season tropical storms are more likely to recurve back into the U.S. Southwest either as a direct storm impact or as a source of moisture for other storm activity. In addition, we associate enhanced eastern Pacific tropical storm activity with El Niño events. In the case of the not-quite-started El Niño of 2018-2019, the oceanic conditions that are the source of the increased likelihood of this event (i.e. elevated sea-surface temperatures) can also help boost tropical storm activity that can impact the Southwest, and is a major reason behind this climatological linkage.

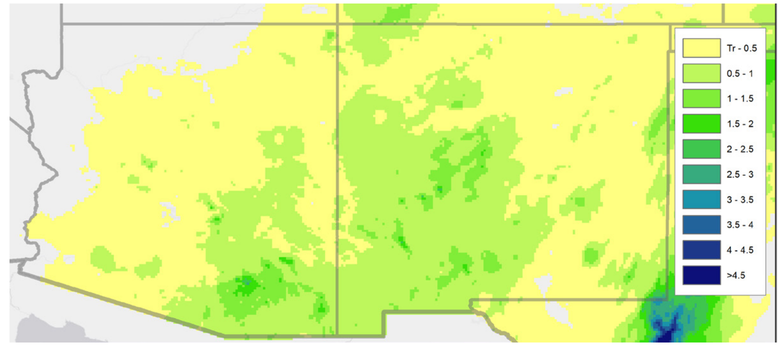


Figure 2: Precipitation June 15 - June 17 (TS Bud)

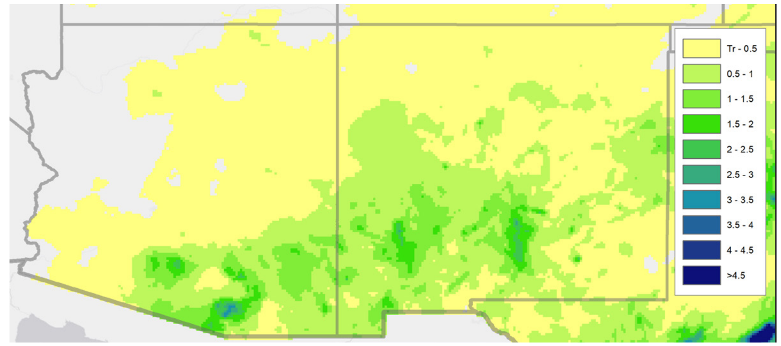


Figure 3: Precipitation Sept 20 - Sept 21 (TD Nineteen-E)

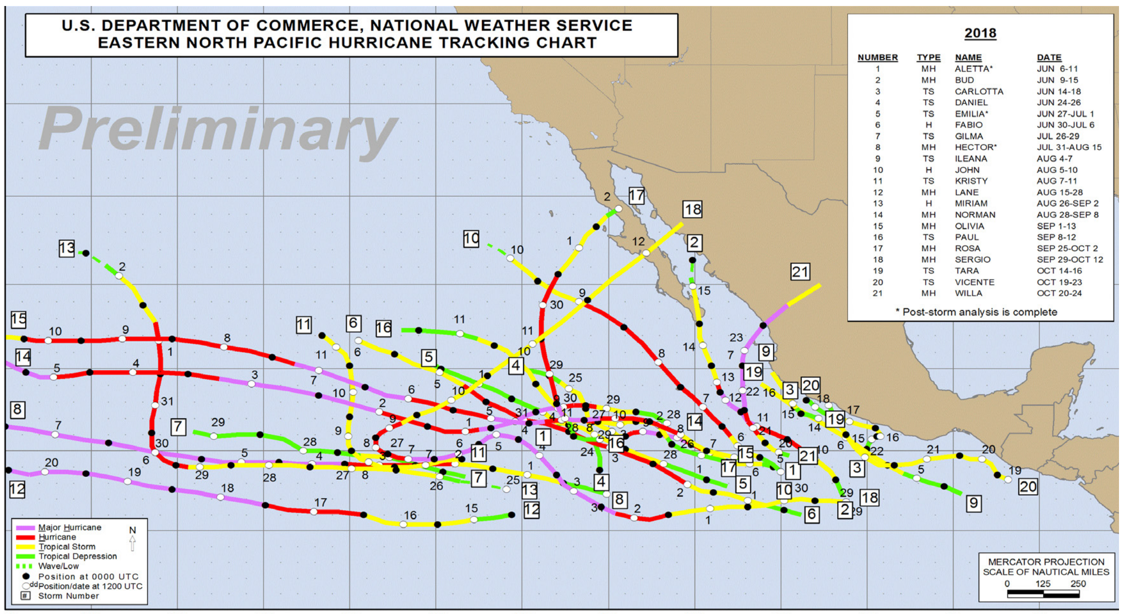


Figure 1: National Weather Service Eastern North Pacific Hurricane Tracking Chart

Online Resources

Figures 4-7
CLIMAS: Climate Assessment for the Southwest
climas.arizona.edu

Data: prism.nacse.org

Hurricane Tracks
NWS National Hurricane Center
nhc.noaa.gov

**For an extended discussion of TS Bud, the monsoon, and monsoon statistics, check out the Southwest Climate Podcast - CLIMAS's monthly podcast on weather and climate in the Southwest*

climas.arizona.edu/podcasts/climas-southwest-climate-podcast

Tropical Storm Recap (cont.)

In mid-June, Tropical Storm Bud caused widespread precipitation across the Southwest just as the monsoon began, kickstarting cumulative monsoon precipitation totals even as some argued it should not be included as part of the monsoon* (Fig. 2). In September, after flooding Sinoloa and Sonora, Mexico, Tropical Depression Nineteen-E brought widespread precipitation to the Southwest (Fig. 3) and was a major contributor to that month's above-normal precipitation (see Oct. 2018 CLIMAS Southwest Climate Outlook). October saw two events having notably different characteristics. Tropical Storm Rosa led to numerous school closures and state of emergency declarations in Mexico in anticipation of the storm, and numerous road and school closures in Baja California and Sonora during and after the storm as a result of flooding. Rosa also brought intense precipitation and severe flooding to the borderlands region of Arizona and up to Phoenix (Fig. 4). One week later, despite its relatively low strength, Tropical Storm Sergio caused widespread school closures and flooding in Baja California and Sonora, Mexico, before bringing more widespread but less-intense precipitation to southern Arizona and parts of New Mexico (Fig. 5). Later in October and early November, storms Vicente, Willa, and Xavier brought additional rainfall, flooding and wind to coastal Mexico and helped fuel even more precipitation in the U.S. Southwest (Figs. 6-7). There is currently no activity in the eastern North Pacific, and the hurricane season officially ends on Nov. 30, but given the widespread activity in October and November (thus far), the region remains vigilant to the possibility of one last late-season tropical storm.

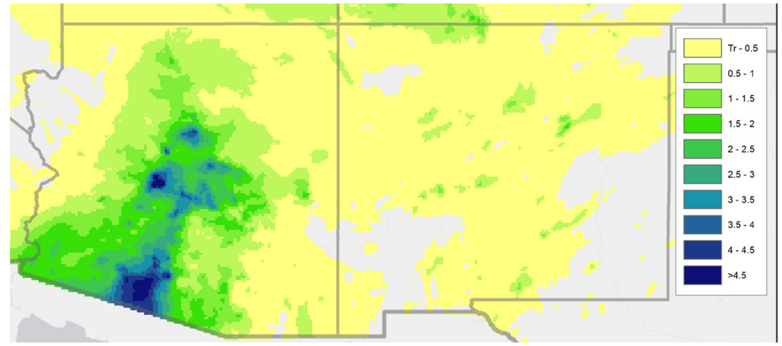


Figure 4: Precipitation Oct 1 - Oct 3 (TS Rosa)

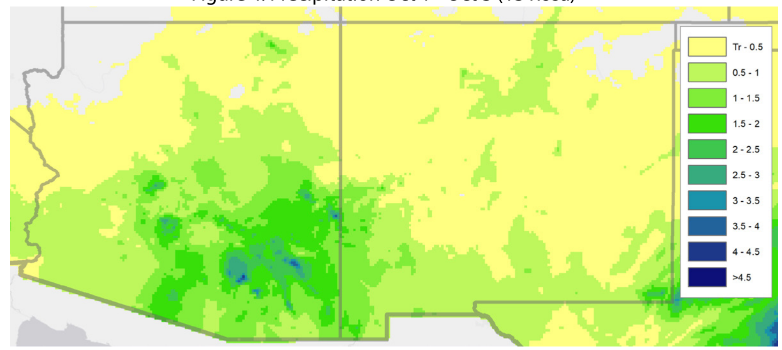


Figure 5: Precipitation Oct 13 - Oct 17 (TS Sergio)

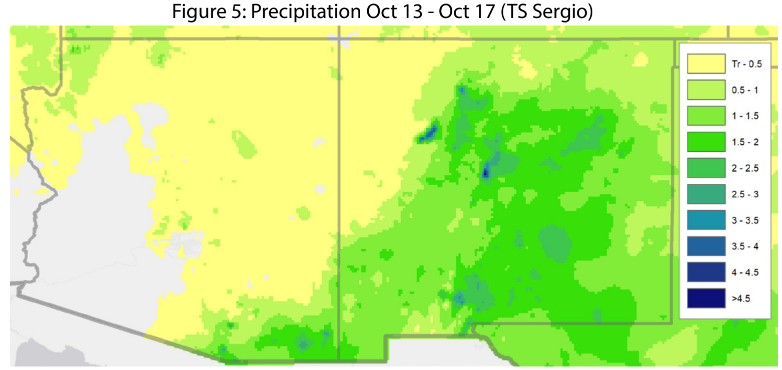


Figure 6: Precipitation Oct 21 - Oct 25 (Hurricane Willa)

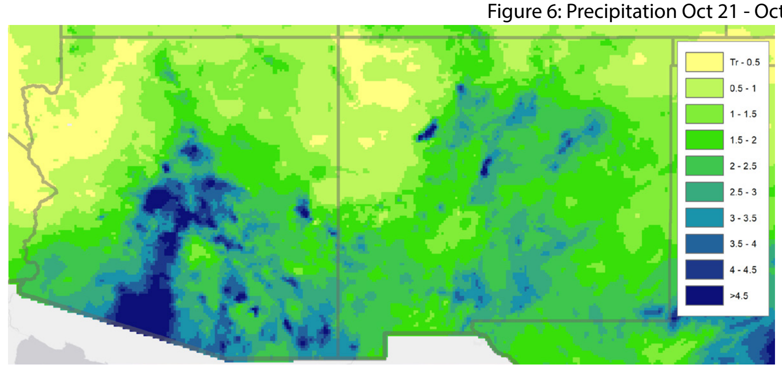


Figure 7: Cumulative TS/Hurricane Precipitation Oct 2018

Online Resources

Portions of the information provided in this figure can be accessed at the Natural Resources Conservation Service

www.wcc.nrcs.usda.gov/BOR/basin.html

Contact Ben McMahan with any questions or comments.

Notes

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).

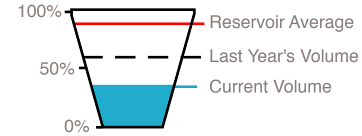
The table details more exactly the current capacity (listed as a percent of maximum storage). Current and maximum storage are given in thousands of acre-feet for each reservoir. One acre-foot is the volume of water sufficient to cover an acre of land to a depth of 1 foot (approximately 325,851 gallons).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

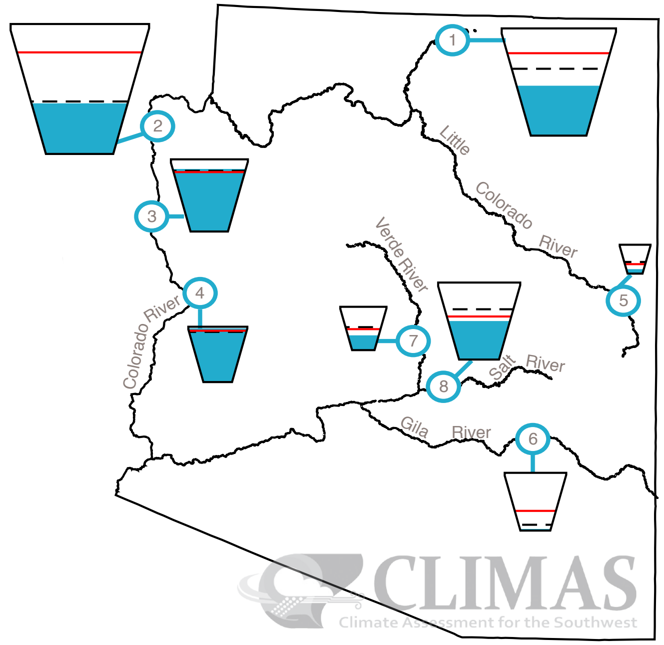
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS).

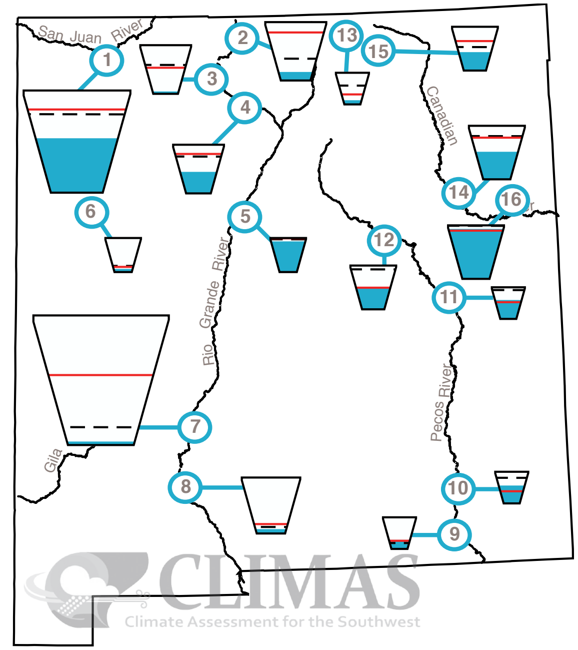
Reservoir Volumes

DATA THROUGH NOV 1, 2018

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	45%	10,862.2	24,322.0	-165.5
2. Lake Mead	38%	9,889.0	26,159.0	19.0
3. Lake Mohave	85%	1,540.0	1,810.0	-19.0
4. Lake Havasu	95%	585.3	619.0	-15.5
5. Lyman	14%	4.3	30.0	-0.5
6. San Carlos	1%	11.1	875.0	4.1
7. Verde River System	33%	94.6	287.4	11.2
8. Salt River System	49%	983.5	2,025.8	8.7

*KAF: thousands of acre-feet

Reservoir	Capacity	Current Storage*	Max Storage*	One-Month Change in Storage*
1. Navajo	53%	896.5	1,696.0	-22.7
2. Heron	15%	61.0	400.0	-3.4
3. El Vado	5%	10.3	190.3	-2.2
4. Abiquiu	44%	82.6	186.8	-7.4
5. Cochiti	90%	44.9	50.0	0.1
6. Bluewater	9%	3.3	38.5	-0.1
7. Elephant Butte	3%	72.5	2,195.0	13.8
8. Caballo	8%	25.8	332.0	1.9
9. Lake Avalon	29%	1.3	4.5	-0.4
10. Brantley	56%	23.7	42.2	4.8
11. Sumner	59%	21.2	35.9	3.0
12. Santa Rosa	51%	53.6	105.9	1.5
13. Costilla	13%	2.1	16.0	0.3
14. Conchas	52%	130.9	254.2	4.2
15. Eagle Nest	42%	33.5	79.0	-1.1
16. Ute Reservoir	94%	187	200	0.0

Online Resources

Figure 1
Climate Program Office
cpo.noaa.gov

RISA Program Homepage
http://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

What is CLIMAS?

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.

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.

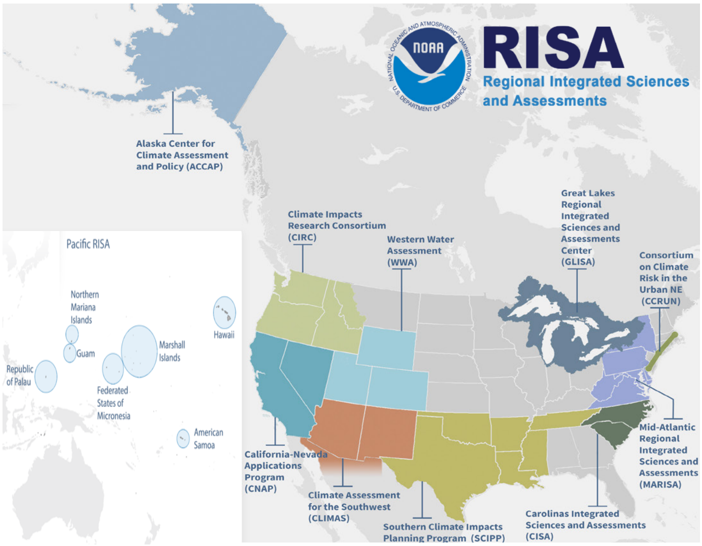


Figure 1: NOAA Regional Integrated Sciences and Assessments Regions

CLIMAS Colloquium Series - Oct 12, 2018

George Frisvold: Update on the Colorado River Shortage Declaration: Planning, Responses and Consequences

youtu.be/M890Bep4DEg

Ben McMahan: Drought/Climate Vulnerabilities and Priorities in Southern Arizona

youtu.be/o2cO91ZeFeU