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July Southwest Climate Outlook

Precipitation and Temperature: Precipitation in June ranged from record driest to much-above average (Fig. 1a); the wetter-than-average areas were those impacted by the remnants of Hurricane Bud in mid-June. June is typically dry, barring an early onset of monsoon activity, so any pre-monsoon precipitation will boost percentile rankings. June temperatures were warmer than average across all of Arizona and New Mexico (Fig. 1b), including record-warm conditions in eastern Arizona and central New Mexico. Notably, unlike recent years, no extreme heat waves affected the region in June, although sustained warmer-than-average temperatures did occur throughout the month and into July (Fig. 2). Year-to-date precipitation and temperature reveal average to record-driest precipitation and much-above-average to record-warmest temperatures (Fig. 3a-b).

Monsoon Tracker: The monsoon is off and running with widespread activity across Arizona and western New Mexico. This uptick in activity is linked to increases in atmospheric moisture (dewpoint, precipitable water), wind patterns, and atmospheric circulations that must come together for storm development and progression. As is often the case in the Southwest, the location and intensity of rainstorms have varied considerably across time and space, with a wide range in observed precipitation across the entire region, and sometimes even within the same metropolitan area (see Monsoon Tracker for details).

Drought: Water-year precipitation to date reveals persistent deficits across most of Arizona and much of New Mexico, including record-dry conditions across the upper third of both states (Fig. 4). With the onset of the monsoon, precipitation and humidity have increased considerably, bringing a stark contrast to the dry conditions of much of the last 12 months. This highlights an annual conundrum: how much does monsoon precipitation mitigate drought conditions in the Southwest? The question centers on the nature of monsoon precipitation, which is often of high intensity and subject to runoff and evaporation, and has a high degree of spatial variability, resulting in "winners" and "losers" in terms of monthly and seasonal totals. The July 19 USDM does not reveal much in the way of improved drought conditions in most of Arizona and New Mexico, as the short-term uptick in precipitation with the onset of the monsoon was not enough to reverse months of precipitation deficits compounded by the impact of warmer- and drier-than-average conditions (Fig. 5).

Wildfire: Widespread moisture and monsoon activity helped tamp down fire risk in July. The fire season is not over yet but the period of highest wildfire risk is. Given the widespread dry, windy, and warm conditions observed in the Southwest this winter and spring, fire season was not as catastrophic as some feared it would be, especially in Arizona (see Fig. 6 for a summary).

El Niño Tracker: Neutral conditions are present in oceanic and atmospheric indicators and are expected to remain neutral through summer. Seasonal outlooks indicate increasing chances of an El Niño event in 2018, with El Niño conditions likely to emerge by fall or winter (see El Niño Tracker for details). Above-average winter precipitation is one characteristic of El Niño in the Southwest, but if the event develops earlier rather than later this fall, it also could help enhance eastern Pacific tropical storm activity. This in turn could promote increased precipitation in the Southwest this fall, especially if these tropical storms bend back into the Southwest and drive moisture into the region. By way of comparison, last year—a La Niña year—brought little tropical storm activity to augment precipitation totals for either the monsoon or the fall season.

Precipitation and Temperature Forecast: The three-month outlook for July through September calls for increased chances of above-normal precipitation in Arizona and western New Mexico, with equal chances in central and eastern New Mexico (Fig. 7, top). The outlook calls for increased chances of above-average temperatures for the entire Southwest (Fig. 7, bottom).

Tweet July 2018 SW Climate Outlook

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JUL2018 @CLIMAS_UA SW Climate Outlook, ENSO Tracker, Monsoon Tracker, AZ & NM Reservoir volumes https://bit.ly/2L5bIdb #SWclimate #AZWX #NMWX #SWCO

July 2018 SW Climate Outlook

Online Resources

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

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

Figure 4
Western Regional Climate Center
wrcc.dri.edu

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

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

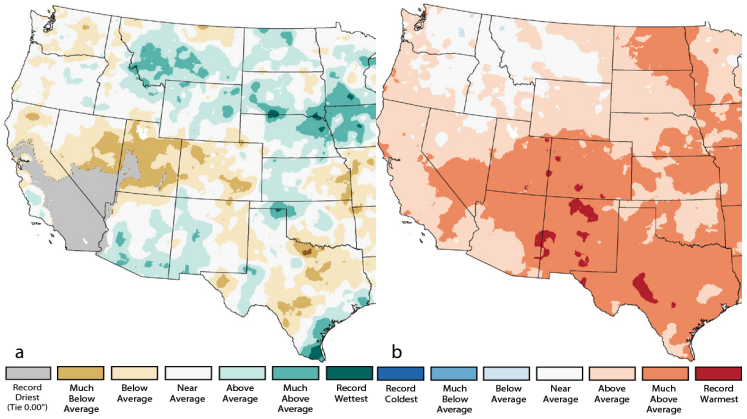


Figure 1: June 2018 Precipitation (a) & Temperature Ranks (b)

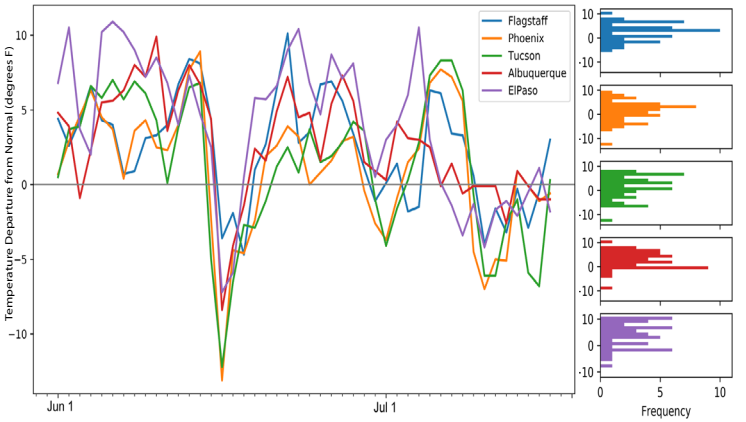


Figure 2: Daily Temperature Anomalies June 1 - July 16 2018 (left) & Frequency of Temperature Anomalies (right)

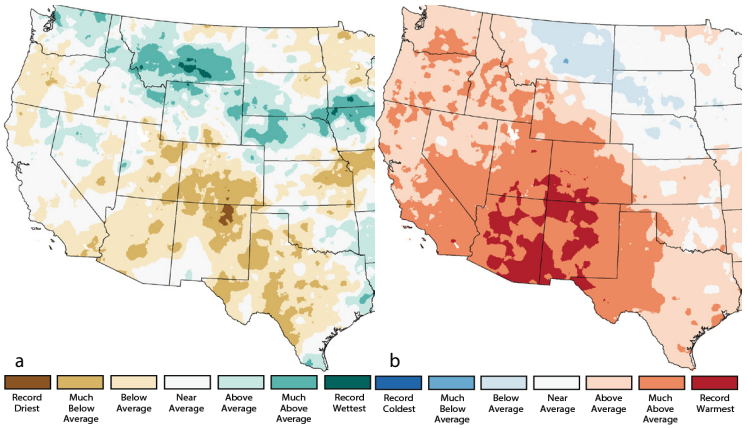


Figure 3: Jan - June 2018 Precipitation (a) & Temperature Ranks (b)

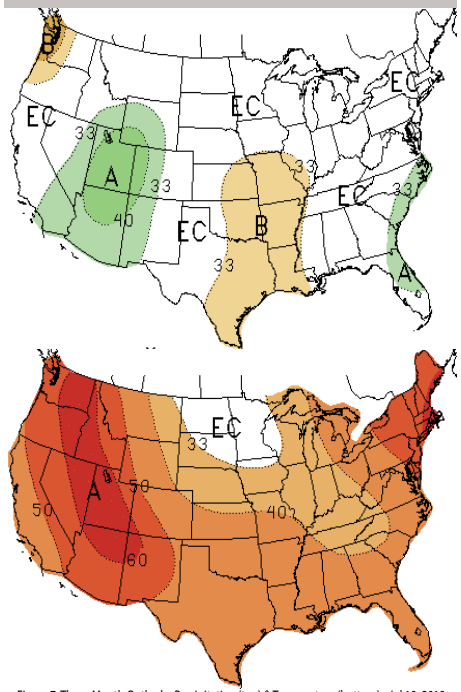


Figure 7: Three-Month Outlook - Precipitation (top) & Temperature (bottom) - Jul 19, 2018

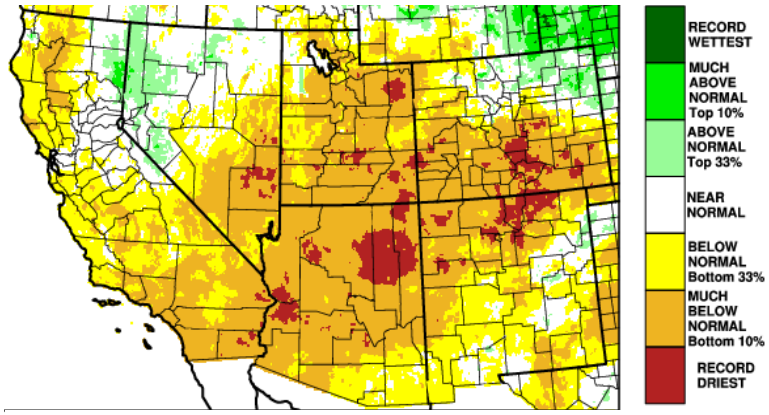


Figure 4: Water Year (Oct 2017 - June 2018) Precipitation Rankings

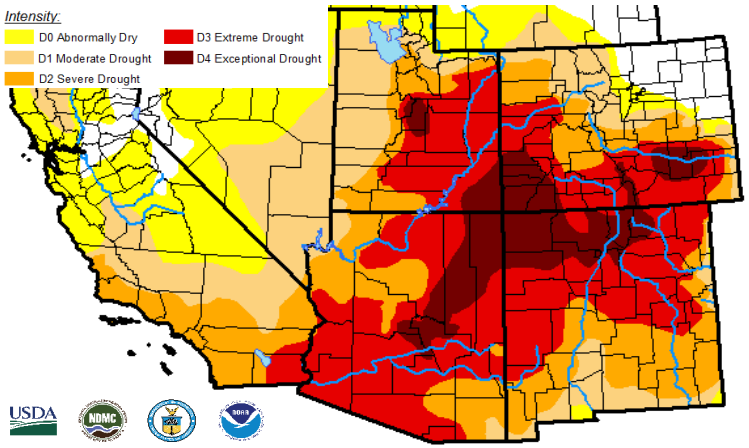


Figure 5: US Drought Monitor - July 17, 2018

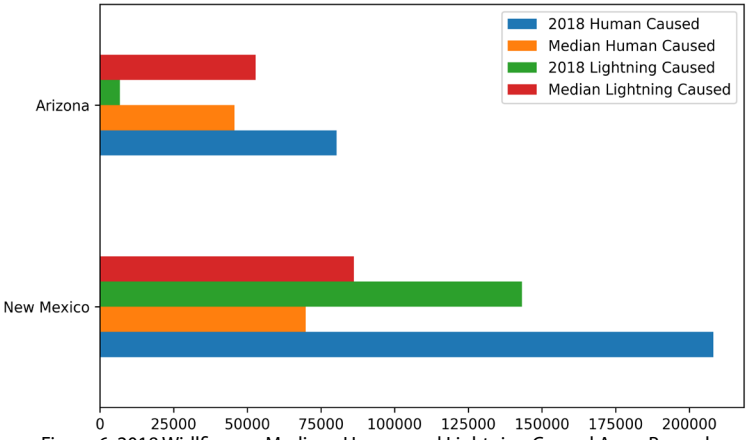


Figure 6: 2018 Widlfires vs. Median - Human and Lightning Caused Acres Burned
Data as of Jul 12, 2018

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

ENSO Tracker

Oceanic and atmospheric conditions remained ENSO-neutral over the last month (Figs. 1-2) and most ENSO forecasts and outlooks reflect that. On July 10, the Japanese Meteorological Agency (JMA) identified neutral conditions in oceanic and atmospheric indicators, but with indications of warming oceanic temperatures in the coming months. The agency forecast equal chances (50 percent) of either ENSO-neutral or El Niño by fall 2018. On July 12, the NOAA Climate Prediction Center (CPC) continued its El Niño watch, observing neutral conditions at present, however the warming oceanic temperatures are seen as an indicator of increasing likelihood of El Niño this year. Its outlook calls for a 65-percent chance of an El Niño event developing this fall, increasing to 70 percent this winter. On July 12, the International Research Institute (IRI) issued an ENSO Quick Look that similarly noted neutral conditions in the oceans and atmosphere now and warming oceanic conditions increasing forecast probabilities for an El Niño event to nearly 70 percent by the end of 2018 (Fig. 3). The forecast predicts weak conditions in the initial event development but potentially reaching moderate strength during the fall and winter. On July 17, the Australian Bureau of Meteorology rated its ENSO Outlook at "El Niño Watch." Most indicators were within the range of neutral, but they too noted steady warming of surface and subsurface waters in the Pacific Ocean that warrant a 50-percent chance of El Niño formation by the end of this year. The North American Multi-Model Ensemble (NMME) also demonstrates the steady trend in observations and forecast toward warmer-than-average ocean temperatures, and is zeroing in on a weak to borderline moderate El Niño event by the end of 2018 (Fig. 4).

Summary: Steady warming in surface and subsurface temperatures in the Pacific led to increasingly bullish forecasts for an El Niño event by the end of 2018, perhaps even sooner. Given the timing and uncertainty in the models and forecasts, the formation of this event is still far from certain, however as mentioned last month, a La Niña event is all but impossible this year. Additionally, the intensity and timing of the event will play a large role in how much it affects tropical storm activity this fall and cool-season precipitation this winter and spring. Most outlooks—for now—are calling for a weak to borderline moderate event.

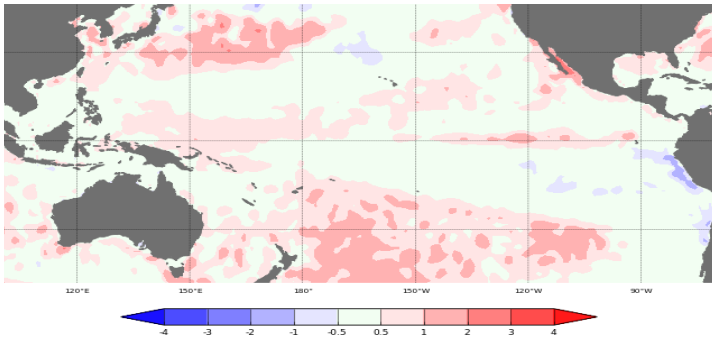


Figure 1: June 2018 Sea Surface Temperature (SST) Anomalies

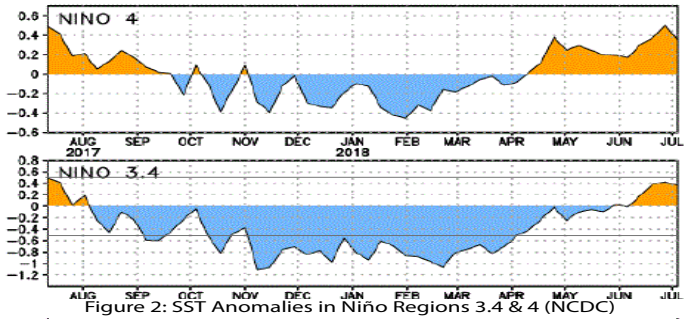


Figure 2: SST Anomalies in Niño Regions 3.4 & 4 (NCDC)

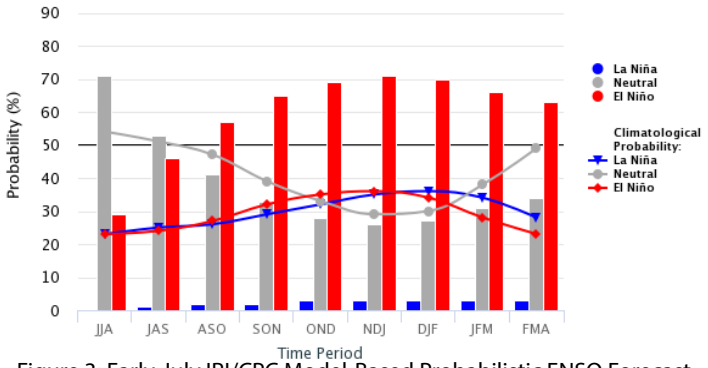


Figure 3: Early-July IRI/CPC Model-Based Probabilistic ENSO Forecast

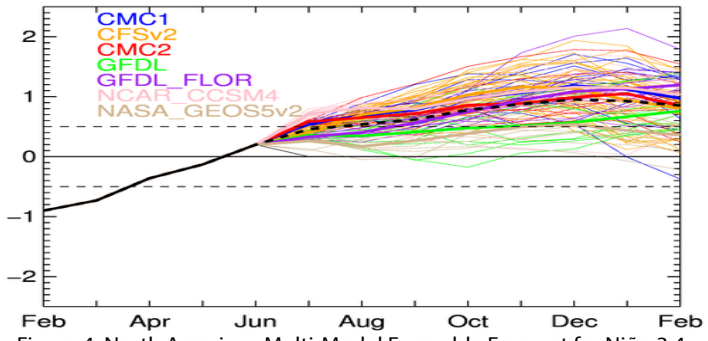


Figure 4: North American Multi-Model Ensemble Forecast for Niño 3.4

Online Resources

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

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

Monsoon Tracker

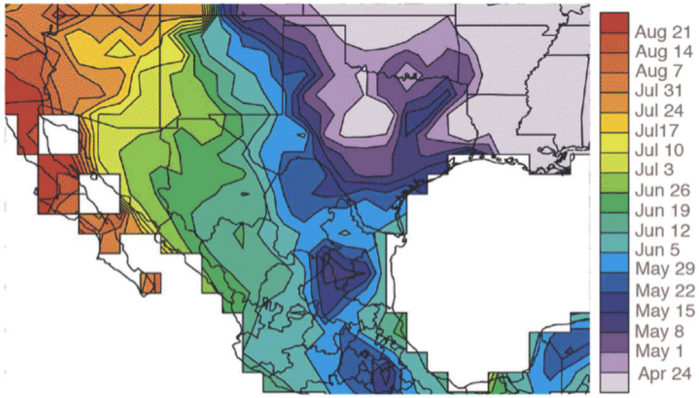


Figure 1: Historical Monsoon Onset Date

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

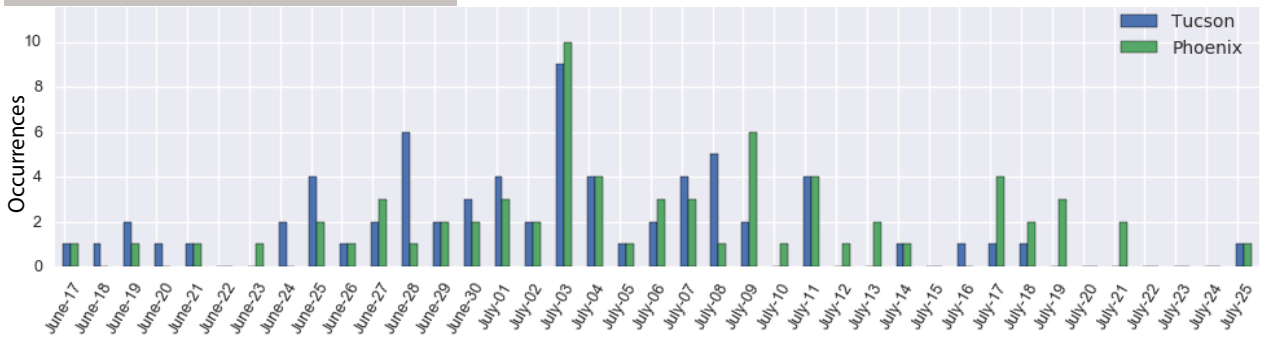


Figure 2: Monsoon Onset (as defined by dewpoint thresholds) in Tucson and Phoenix, Frequency by Date (1949-2016)

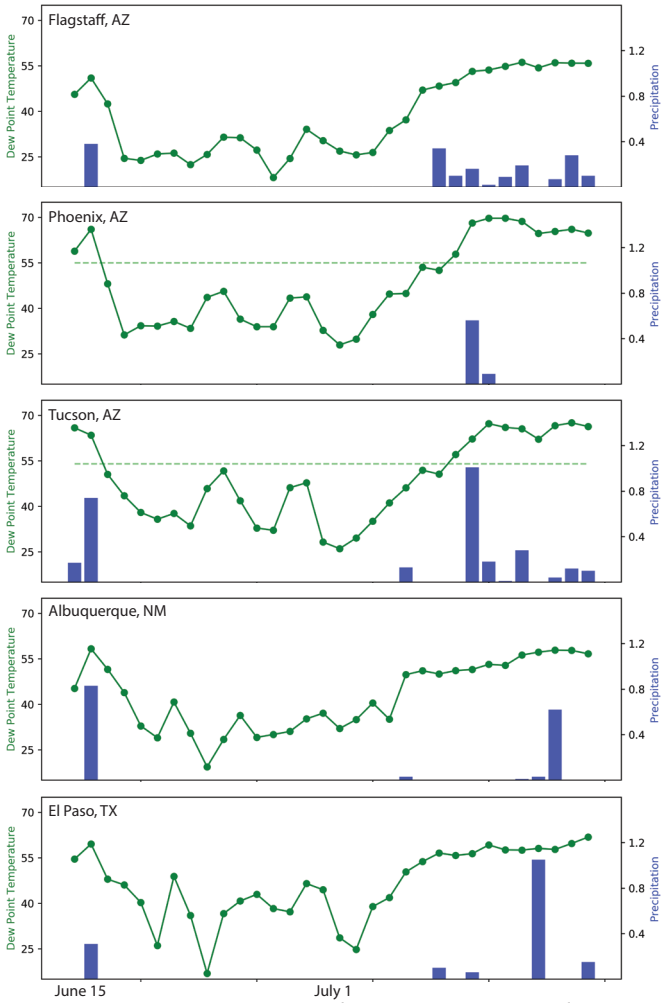


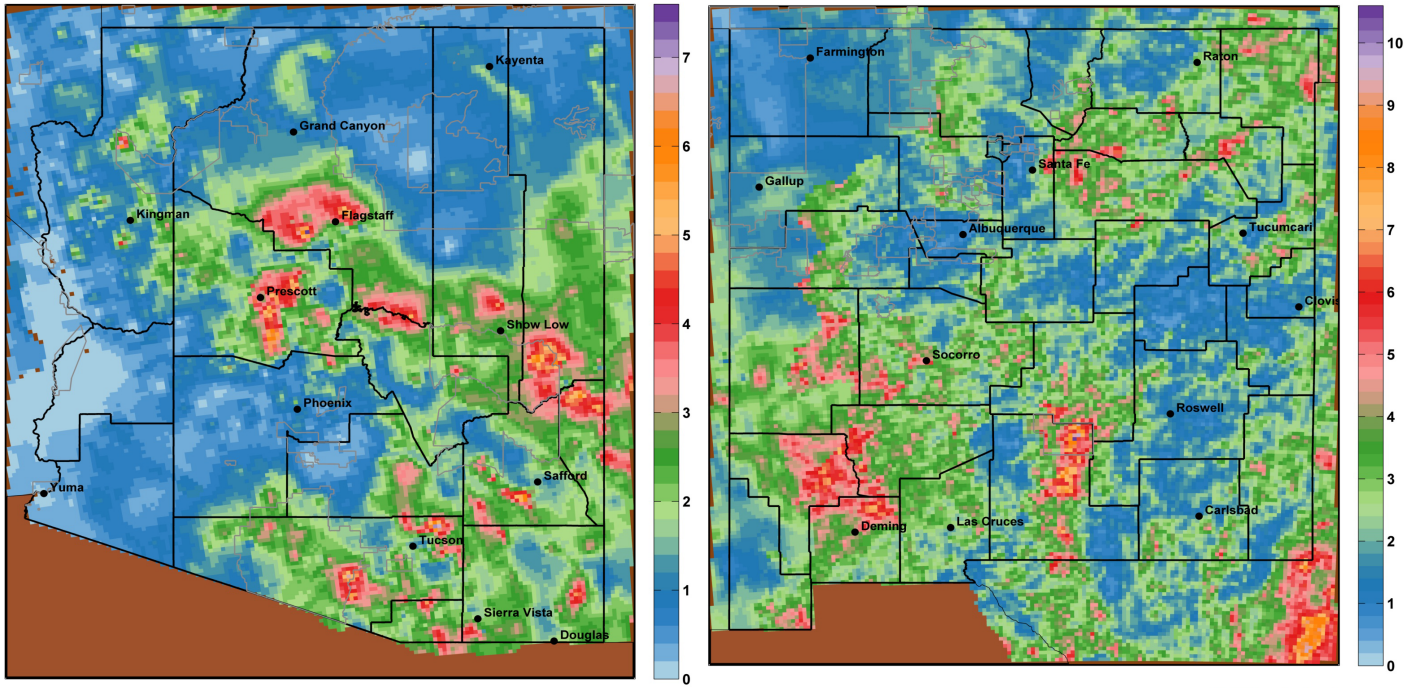
Figure 3: Dew Point Temperature & Daily Precipitation - Jun 15 - Jul 16, 2018

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 (Fig. 2). Using that definition, the monsoon began in Tucson and Phoenix on July 8 this year. While an imperfect measure, this increase in dewpoint temperature contextualizes the slightly later-than-average start to monsoon activity compared to climatology, and roughly corresponds with upticks in precipitation activity across the Southwest (Fig. 3). Despite the relatively late start, the monsoon is now in full swing. The seasonal totals to date (Fig. 4 on p. 5), the percent of normal precipitation (Fig. 5 on p. 5) and percent of days with rain (Fig. 6 on p. 5) all help characterize the spatial variability and intensity of the monsoon thus far. Tucson's monsoon precipitation (p. 6) illustrates the amount of variability that can occur at a municipal scale.

Online Resources

Figures 4-6
UA Climate Science Application Program
cals.arizona.edu/climate

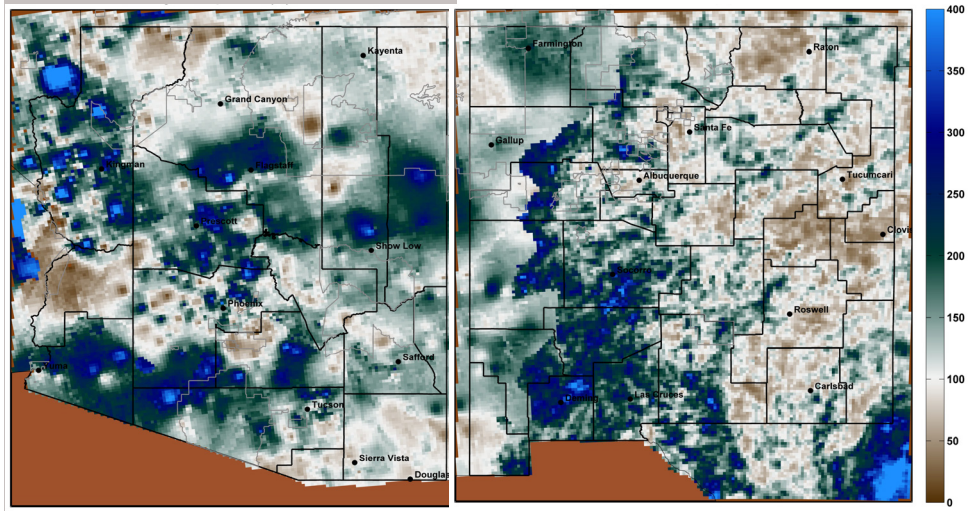
Monsoon Tracker



Map produced using daily total precipitation estimates from the NOAA National Weather Service Advanced Hydrologic Prediction Service (AHPS). Data information available at http://water.weather.gov/precip/about.php. Date created: 17-Jul-2018 University of Arizona - http://cals.arizona.edu/climate/

Map produced using daily total precipitation estimates from the NOAA National Weather Service Advanced Hydrologic Prediction Service (AHPS). Data information available at http://water.weather.gov/precip/about.php. Date created: 17-Jul-2018 University of Arizona - http://cals.arizona.edu/climate/

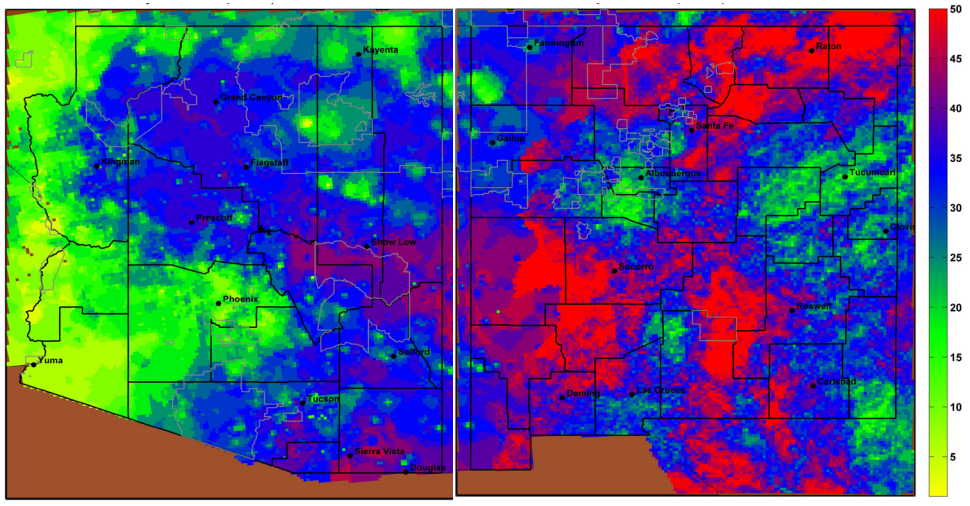
Figure 4a-b: Total Precipitation - Jun 15 - Jul 16, 2018



Map produced using daily total precipitation estimates from the NOAA National Weather Service Advanced Hydrologic Prediction Service (AHPS). Data information available at http://water.weather.gov/precip/about.php. Date created: 17-Jul-2018 University of Arizona - http://cals.arizona.edu/climate/

Map produced using daily total precipitation estimates from the NOAA National Weather Service Advanced Hydrologic Prediction Service (AHPS). Data information available at http://water.weather.gov/precip/about.php. Date created: 17-Jul-2018 University of Arizona - http://cals.arizona.edu/climate/

Figure 5a-b: Percent of Normal Precipitation - Jun 15 - Jul 16, 2018



Map produced using daily total precipitation estimates from the NOAA National Weather Service Advanced Hydrologic Prediction Service (AHPS). Data information available at http://water.weather.gov/precip/about.php. Date created: 17-Jul-2018 University of Arizona - http://cals.arizona.edu/climate/

Map produced using daily total precipitation estimates from the NOAA National Weather Service Advanced Hydrologic Prediction Service (AHPS). Data information available at http://water.weather.gov/precip/about.php. Date created: 17-Jul-2018 University of Arizona - http://cals.arizona.edu/climate/

Figure 6a-b: Percent of Days With Precipitation (>0.01") - Jun 15 - Jul 16, 2018

Online Resources

Figures 7-8
CLIMAS: Climate Assessment for the Southwest
climas.arizona.edu

Data: RainLog.org & Pima County Flood Control District

CLIMAS has a new project in collaboration with the National Weather Service in Tucson exploring how to integrate citizen science rainfall observations into monsoon analysis and visualizations, and to compare these observations to official stations and radar derived estimates of precipitation. If you have any questions or want more infomation, contact Ben McMahan at bmcmahan@email.arizona.edu

RainLog: rainlog.org
CoCoRaHs: cocorahs.org

Monsoon Tracker (cont)

Within the Tucson metropolitan region, an initial surge of activity associated with the remnants of Hurricane Bud brought considerable rainfall to the region June 15-17 (see last month's Outlook for details). For much of the rest of June and the first week of July, however, there were few storms. Around July 8, rainfall picked up with widespread activity on a nearly daily basis, but with a wide range of daily totals from site to site (Fig. 7). Cumulative totals for the first month of the monsoon further reveal the extent to which some areas have received frequent and/or abundant precipitation, while others locations–often relatively nearby–have not (Fig. 8).

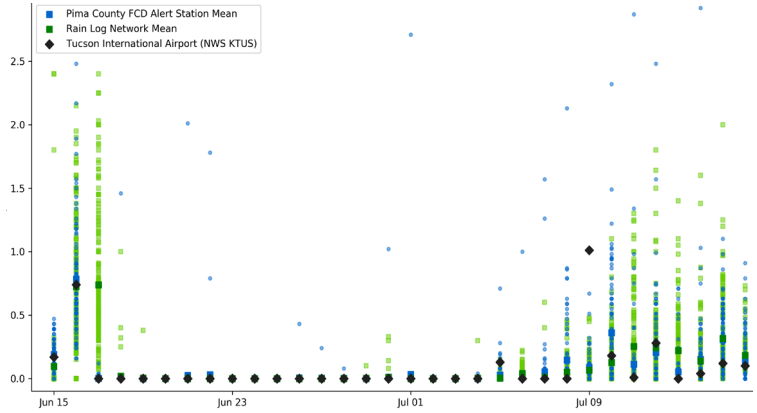


Figure 7: Monsoon Precipitation Jun 15 - Jul 16 (Pima County FCD, Rain Log, and Tucson Int. Aiport)

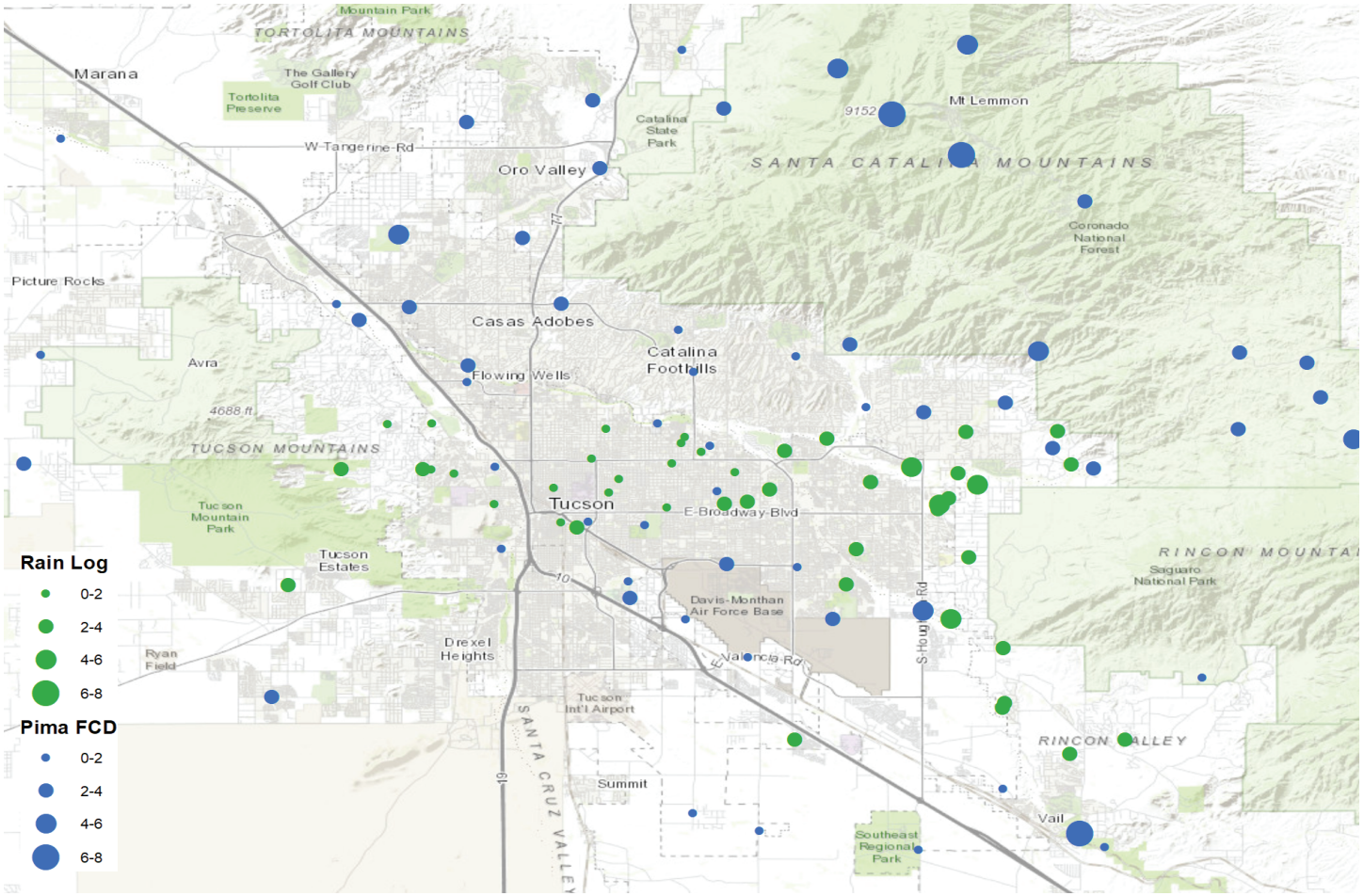


Figure 8: Cumulative Precipitation Jun 15 - Jul 16, 2018 (Rainlog & Pima FCD Networks)

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 about these or any other suggested revisions.

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).

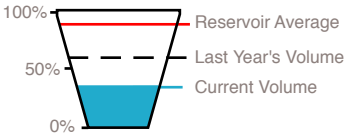
The table details more exactly the current capacity (listed as a percent of maximum storage). Current and maximum storage are given in thousands of acre-feet for each reservoir. One acre-foot is the volume of water sufficient to cover an acre of land to a depth of 1 foot (approximately 325,851 gallons).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

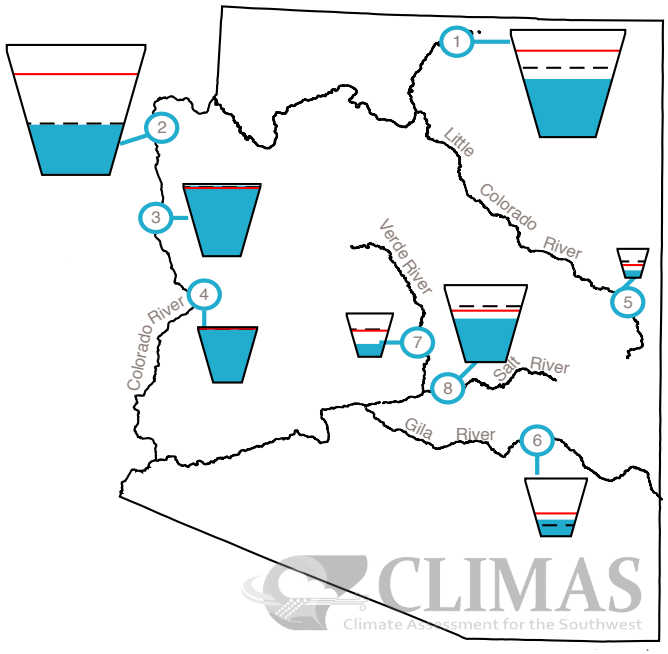
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS).

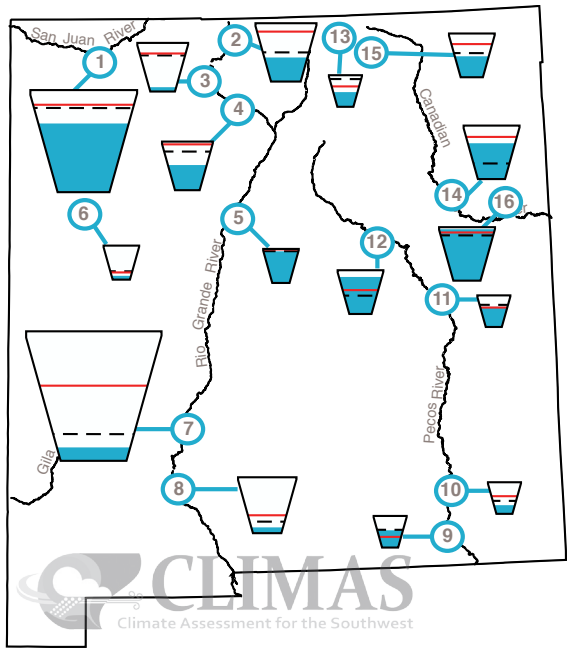
Reservoir Volumes

DATA THROUGH JUNE 30, 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	52%	12,728.3	24,322.0	-157.7
2. Lake Mead	37%	9,748.0	26,159.0	-263.0
3. Lake Mohave	96%	1,734.0	1,810.0	31.0
4. Lake Havasu	95%	590.3	619.0	-1.0
5. Lyman	24%	7.1	30.0	-1.6
6. San Carlos	27%	235	875.0	222.3
7. Verde River System	28%	80.3	287.4	-4.8
8. Salt River System	55%	1,120.5	2,025.8	-70.2

*KAF: thousands of acre-feet

Reservoir	Capacity	Current Storage*	Max Storage*	One-Month Change in Storage*
1. Navajo	68%	1,159.3	1,696.0	-63.9
2. Heron	41%	164.4	400.0	-2.3
3. El Vado	9%	16.3	190.3	-37.5
4. Abiquiu	51%	96.0	186.8	-14.1
5. Cochiti	93%	46.4	50.0	0.0
6. Bluewater	11%	4.3	38.5	-1.0
7. Elephant Butte	10%	227.7	2,195.0	-110.2
8. Caballo	10%	34.0	332.0	-4.7
9. Lake Avalon	55%	2.5	4.5	0.4
10. Brantley	28%	12.0	42.2	-13.2
11. Sumner	64%	22.9	35.9	-3.5
12. Santa Rosa	84%	89.4	105.9	-1.7
13. Costilla	45%	7.2	16.0	-3.2
14. Conchas	66%	168.7	254.2	-17.4
15. Eagle Nest	48%	38.0	79.0	-2.5
16. Ute Reservoir	96%	191	200	-3.0

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

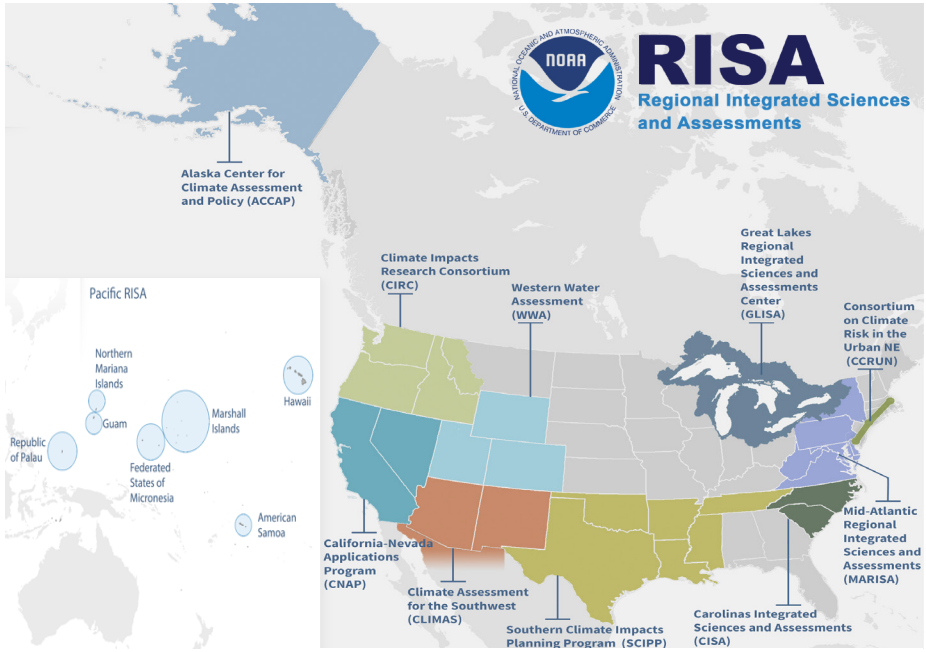
climas.arizona.edu/climate-services

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.

July 2018 SW Climate Podcast

A Little Better than Climatology - A Fast Start to "Monsoon" Precip and Optimism for the Season

The monsoon is back! In the July edition of the CLIMAS Southwest Climate Podcast, Mike Crimmins and Zack Guido kick off with a recap of the role that Hurricane Bud played in driving storms and moisture into the Southwest on June 15-16, with a focus on the tropical moisture incursion that occurred during the transitional season. They even take a moment to discuss whether that event *was* the monsoon, or just–in Mike's words–"monsoon-y." Next, they turn to the onset of the actual monsoon in terms of a few different metrics (precipitation, dewpoint, precipitable water), the atmospheric patterns that affect this onset, and how this shift has affected recent temperatures, wildfire activity, and where and how precipitation is falling. They briefly discuss El Niño, as well as the seasonal outlooks that forecast a relatively rosy picture (i.e. wet) for Arizona and parts of New Mexico over the next few weeks and months.

https://bit.ly/2LgS8H0