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October Southwest Climate Outlook

Precipitation: Over the past 30 days, most of Arizona and much of New Mexico recorded average or near-average precipitation, with notable exceptions in portions of southeast Arizona and large swaths of southeast New Mexico (Fig. 1). Even as the monsoon was wrapping up, the region had repeated incursions of tropical moisture, which brought occasional precipitation and helped keep dewpoints above expected values.

Temperature: Temperatures in the past 30 days were above average across most of the Southwest, with temperature anomalies between 0 and 6 degrees F across most of Arizona and New Mexico (Fig. 2). Average temperatures in September were record warm in New Mexico, and among the top five warmest in Arizona.

Monsoon: Variable spatial coverage and intensity, along with intermittent precipitation events, makes it difficult to characterize any monsoon as "normal." That said, 2015 has been fairly typical for monsoon precipitation; and despite a persistent break in monsoon activity for much of August and early September, most locations saw regular precipitation events that brought their total precipitation close to long-term averages (see Monsoon Recap, pages 5-6 for details).

Tropical Storm Activity: El Niño events are associated with increased eastern Pacific tropical storm activity, and this year is no exception. At time of this writing, the eastern Pacific tropical storm season had recorded 10 hurricanes, seven of them major, four tropical storms, and three tropical depressions (Fig. 3). Accumulated cyclone energy (ACE) is a measure of tropical storm and hurricane strength and duration, and according to the National Hurricane Center, ACE was approximately 25 percent higher than the median value at the end of September. Activity has slowed somewhat in October, and the extent to which additional tropical systems will affect the Southwest in 2015 remains to be seen. While not directly related to monsoon circulation patterns, tropical storm activity is part of the seasonal cycle, helped buoy precipitation totals, and brought abundant moisture and persistently above-average dewpoint temperatures into the region.

Drought & Water Supply: The U.S. Drought Monitor identifies persistent multi-year drought across the West (Fig. 4). Arizona and New Mexico are still recovering from years of accumulated drought and water deficits, but average to above-average 2015 water year precipitation (October 1, 2014 to September 30, 2015) helped alleviate drought conditions, particularly in eastern New Mexico. Years of accumulated drought are not erased overnight, and while there is hope for above-average precipitation this winter (See El Niño Tracker, pages 3-4), the possibility remains of a rapid transition into La Niña conditions, which tend to bring below-average precipitation to the Southwest.

Precipitation & Temperature Forecasts: The Oct. 15 NOAA-Climate Prediction Center seasonal outlook predicts above-average precipitation for most of the Southwest this fall into winter (Fig. 5, top). Northern California and most of the Northwest are notable exceptions. Temperature forecasts are split, with elevated chances for above-average temperatures along the West Coast and extending to the western edge of Arizona, and increased chances for below-average temperatures centered over Texas and extending across most of New Mexico (Fig. 5, bottom).

Tweet Oct SW Climate Outlook

CLICK TO TWEET

Oct2015 @CLIMAS_UA SW Climate Outlook - Climate Summary, ENSO Updates, Monsoon Recap, and Water Storage - http://bit.ly/1MFDRQZ

Online Resources

Figure 1
National Weather Service - AHPS
http://water.weather.gov/precip

Figure 2
High Plains Regional Climate Center - HPRCC
http://www.hprcc.unl.edu/

Figure 3
NWS National Hurricane Center
http://www.nhc.noaa.gov/

Figure 4
U.S. Drought Monitor
http://droughtmonitor.unl.edu/

Figure 5
NWS Climate Prediction Center
http://www.cpc.ncep.noaa.gov/

CLIMAS YouTube Channel

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www.youtube.com/user/UACLIMAS/

Podcasts

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www.climas.arizona.edu/media/podcasts

October Southwest Climate Outlook

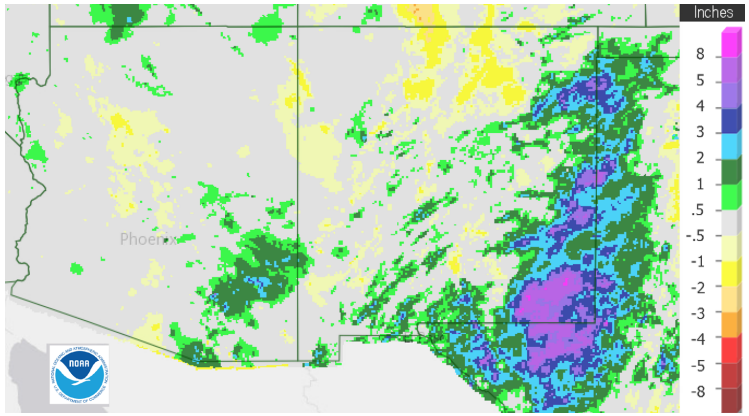

Figure 1: Departure from Normal Precipitation - Past 30 Days

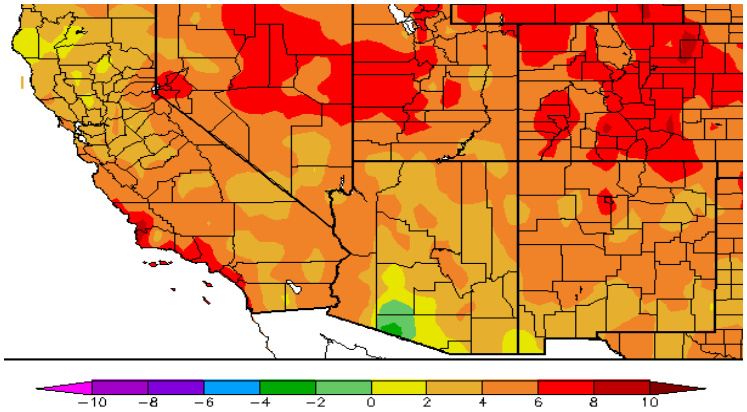

Figure 2: Departure from Normal Temperature - Sep 15 - Oct 14, 2015

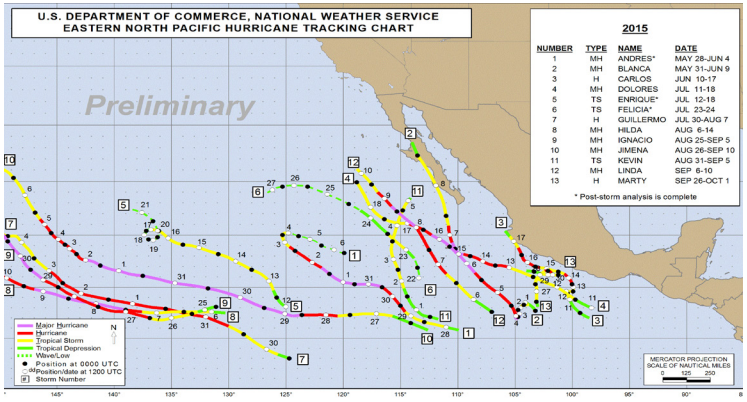

Figure 3: 2015 Named Hurricanes and Tropical Storms

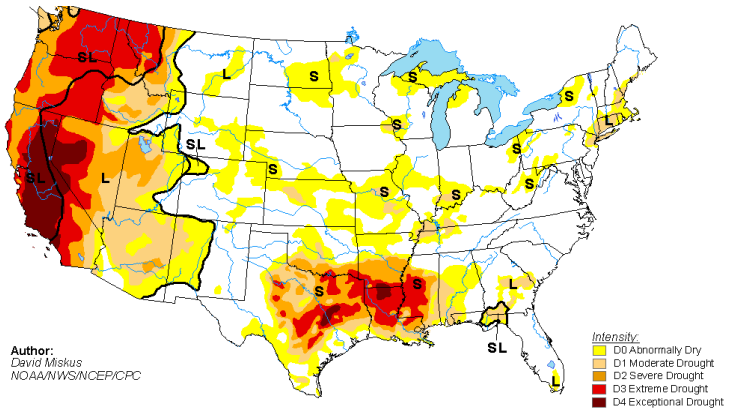

Figure 4: US Drought Monitor - Oct 13, 2015

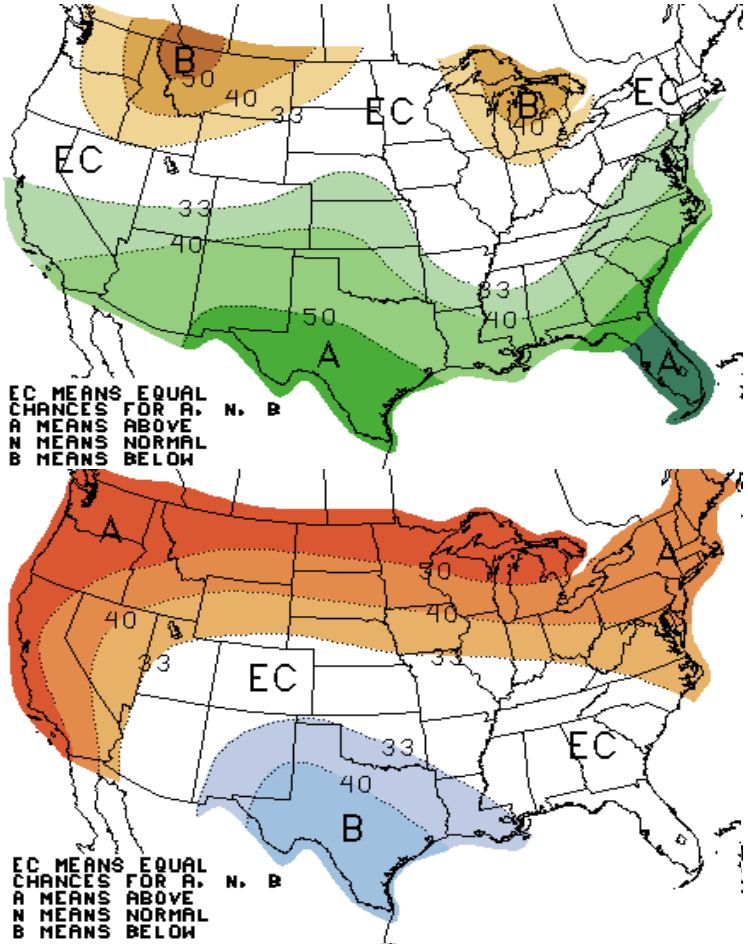

Figure 5: Three-Month Precipitation & Temperature Outlook - Oct 15, 2015

Online Resources

Figure 1
Australian Bureau of Meteorology
http://www.bom.gov.au/climate/enso/index.shtml

Figure 2
NOAA - National Climatic Data Center
http://www.ncdc.noaa.gov/teleconnections/enso/

Figure 3
International Research Institute for Climate and Society
http://iri.columbia.edu/our-expertise/climate/forecasts/enso/

El Niño-Southern Oscillation

Information on this page is also found on the CLIMAS website:
www.climas.arizona.edu/sw-climate/el-niño-southern-oscillation

El Niño-Southern Oscillation (ENSO)

We spent the better part of 2014 (and the first part of 2015) waiting in anticipation for an El Niño event that was initially forecast to be one of the stronger events on record. By early 2015, the event in question had not yet materialized, and some questioned whether El Niño would ever arrive. Eventually it did, and has been going strong for months, with most forecasts indicating that it will remain a strong event through the winter. As this event unfolds, there are numerous impacts we might expect to see across the Southwest over the course of our cool season (approximately Oct - Mar). In the coming months, CLIMAS will aggregate news, information, and commentary about the possible and expected impacts of El Niño, from the perspective of what is most relevant and applicable to the Southwest. This will include what we have learned from past events, and what forecasting and models can tell us about planning for this event.

For more information, please visit www.climas.arizona.edu/sw-climate/el-niño-southern-oscillation, our repository for ENSO related materials, which we will update with timely and relevant information about El Niño throughout the winter.

2015 El Niño Tracker

El Niño conditions continued for an eighth straight month, and models continue to forecast a strong El Niño event that likely will last through spring 2016 and remain strong through the early part of the year. Forecasts focused on the persistence of sea-surface temperature (SST) anomalies (Figs.1–2) and weakened trade winds, enhanced convective activity in the central and eastern Pacific, and El Niño-related ocean-atmosphere coupling.

On October 8, the NOAA-Climate Prediction Center (CPC) extended its El Niño advisory, predicting a 95 percent chance that the current strong El Niño conditions will continue through winter 2015–2016, with gradual weakening into spring 2016 (Fig. 3). The center cited persistent positive SST anomalies in the central and eastern Pacific and ongoing ocean-atmospheric coupling and convection activity as indicators of an ongoing and strengthening event. On October 9, the Japan Meteorological Agency identified ongoing El Niño conditions in the equatorial Pacific, noting "remarkably above-normal" SST anomalies and convective activity, and forecast the current El Niño conditions would continue into spring. On October 13, the Australian Bureau of Meteorology maintained its tracker at official El Niño status, noting the strongest event seen since 1997, and forecast the event will persist into early 2016. On October 15, the International Research Institute for Climate and Society (IRI) and CPC forecasts indicated a 100 percent chance of El Niño through early 2016, and saw continued evidence in both the ocean and atmosphere that this event would be one of the strongest events on record.

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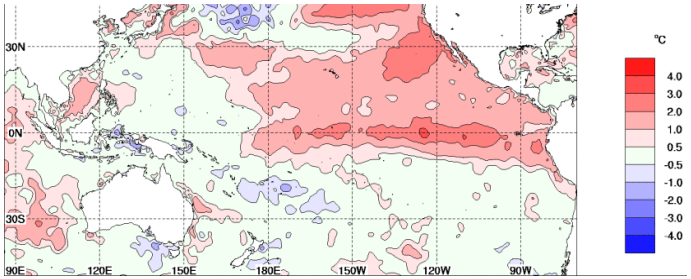


Figure 1: Aug 2015 Sea Surface Temperature (SST) Anomalies

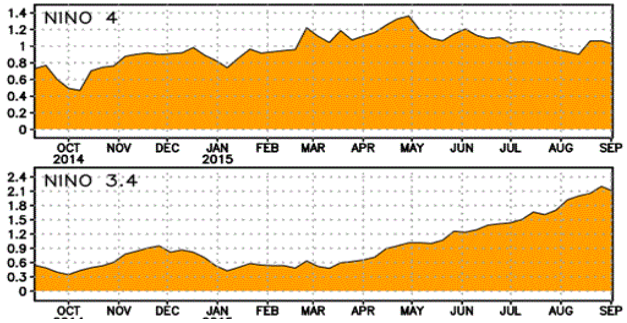


Figure 2: SST Anomalies in Niño Regions 3.4 & 4 (NCDC)

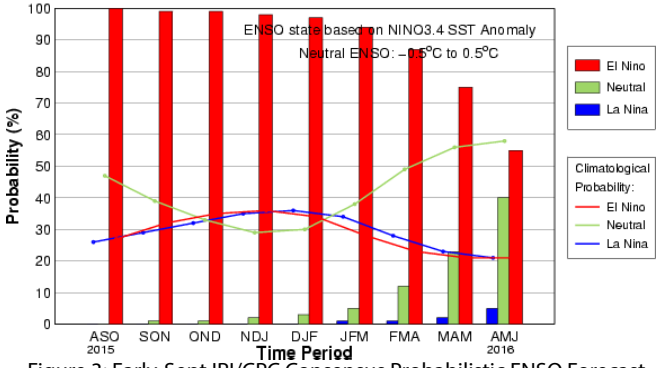


Figure 3: Early-Sept IRI/CPC Consensus Probabilistic ENSO Forecast

Online Resources

Figure 4
NOAA - Climate Prediction Center
http://www.cpc.ncep.noaa.gov/products/NMME/current/plume.html

Figures 5-8
Westwide Drought Tracker
http://www.wrcc.dri.edu/wwdt/

El Niño-Southern Oscillation

Information on this page is also found on the CLIMAS website:
www.climas.arizona.edu/sw-climate/el-niño-southern-oscillation

2015 El Niño Tracker

The North American multi-model ensemble currently shows a strong event extending into 2016 with gradual weakening heading into spring (Fig. 4). We continue to grapple with this El Niño event and the potential impacts it might bring to the Southwest over the winter and into spring, especially given current forecasts that have it pegged as one of the strongest events on record. Seasonal forecasts (see Fig. 5 on page 2) and past events suggest we might expect well above-average precipitation totals across our cool season. This does not mean we should expect a winter of daily rains, however. Variability across these months means we may see periods of below-average precipitation as well.

Looking at the 1997–1998 event—the strongest El Niño event on record—most of Arizona and New Mexico received above-average precipitation in December but below-normal precipitation for all of January before returning to normal or above-normal precipitation in February and March (Figs. 5–8). At this point, we are fairly certain that El Niño will remain on the current trajectory, and we will see one of the top three strongest events on record since 1950. This is likely to bring above-average winter precipitation to the Southwest, particularly later in the season, but it is far from a guarantee. Additionally, what happens in late spring and early summer may determine the longer-term impacts. If we bounce back into La Niña conditions, as happened after the 1997–1998 event, we may see a return to more below-average precipitation forecasts heading into 2016–2017.

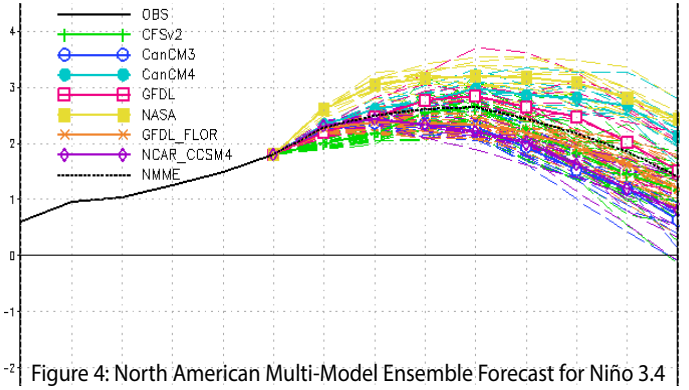


Figure 4: North American Multi-Model Ensemble Forecast for Niño 3.4

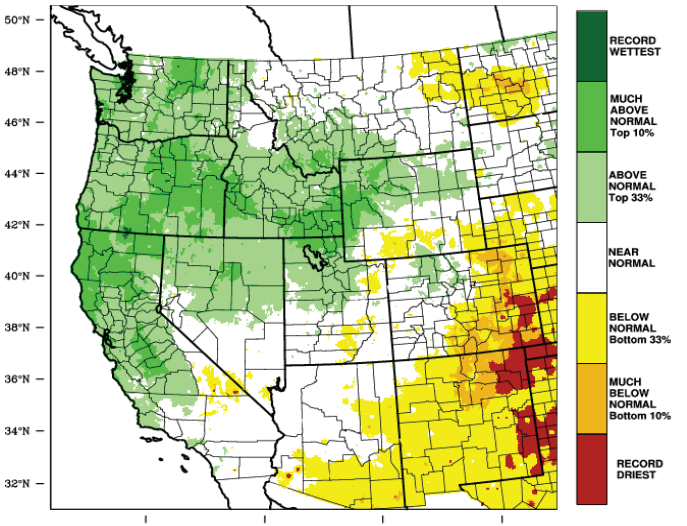


Figure 6: January 1998 Precipitation Percentile - WestWide Drought Tracker

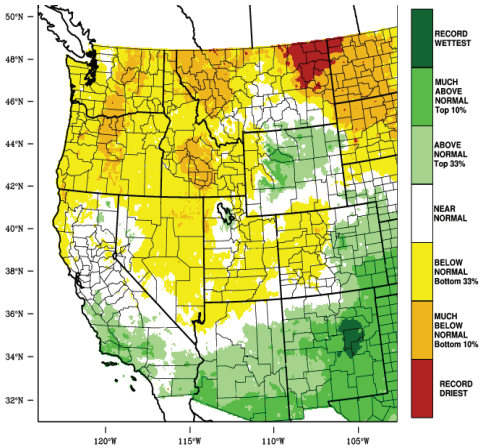


Figure 5: December 1997 Precipitation Percentile - WestWide Drought Tracker

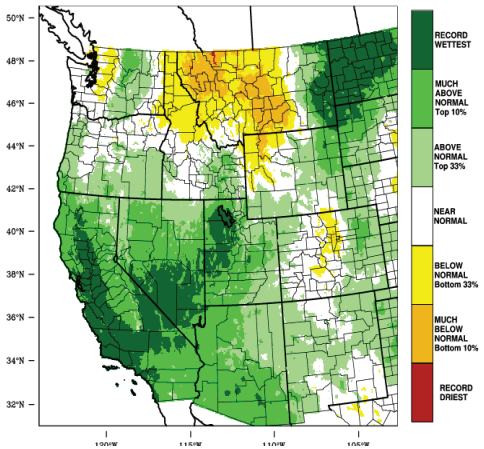


Figure 7: February 1998 Precipitation Percentile - WestWide Drought Tracker

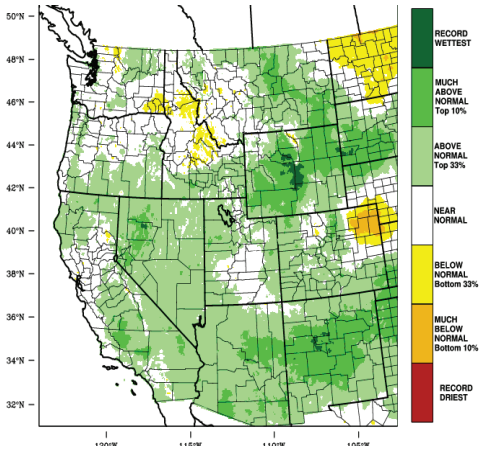


Figure 8: March 1998 Precipitation Percentile - WestWide Drought Tracker

Online Resources

Figure 1
National Center for Environmental Information
https://www.ncdc.noaa.gov

Figure 2
NOAA - National Weather Service
http://www.wrh.noaa.gov/twc/monsoon/dewpoint_tracker.php

For more information on the monsoon, pleast visit:
http://www.climas.arizona.edu/sw-climate/monsoon

2015 Monsoon Recap

The monsoon started strong in late June and early July. This early start centered on Arizona, which recorded its second wettest June on record (Fig. 1a), with a return to relatively normal rainfall totals in July. New Mexico saw an increase in precipitation, recording its 10th wettest July on record (Fig. 1b). Following a break in the monsoon circulation, rainfall in August and September was average in Arizona and below average for New Mexico (Figs. 1c-1d). These statewide rankings do little to capture the spatial and temporal variability of the monsoon (see below), but they do give a sense as to the general character of the monsoon. As noted in the October SW Climate Podcast, the monsoon started strong, but tended to fizzle for most of August and September. However we did see a late season push from tropical storm activity, which helped push some of the monsoon seasonal precipitation totals just above average values.

Shifts in the persistence and intensity of the monsoon are tied to the strength and location of the monsoon ridge, which, depending on its location, can facilitate the flow of organized storm activity from the south or east (during increased monsoon activity), or can shift the flow such that we see extended periods of decreased precipitation. The weakening of the monsoon ridge since early July is likely due at least in part to increasing El Niño convection. With this El Niño event set to be one of the strongest on record, it is not surprising that it may have had an expected disruptive effect on monsoon circulation.

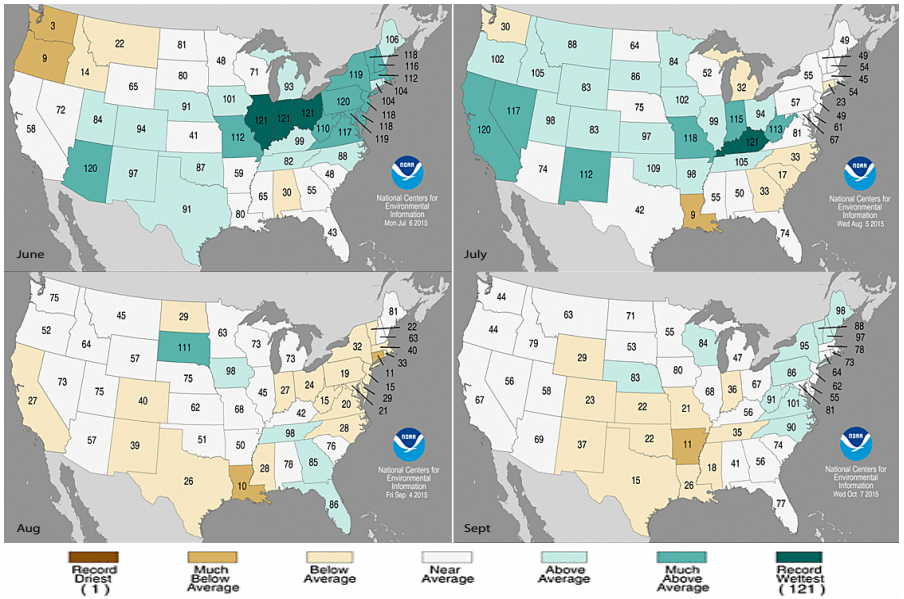


Figure 1: Statewide Precipitation Ranks June, July, Aug, & Sept 2015

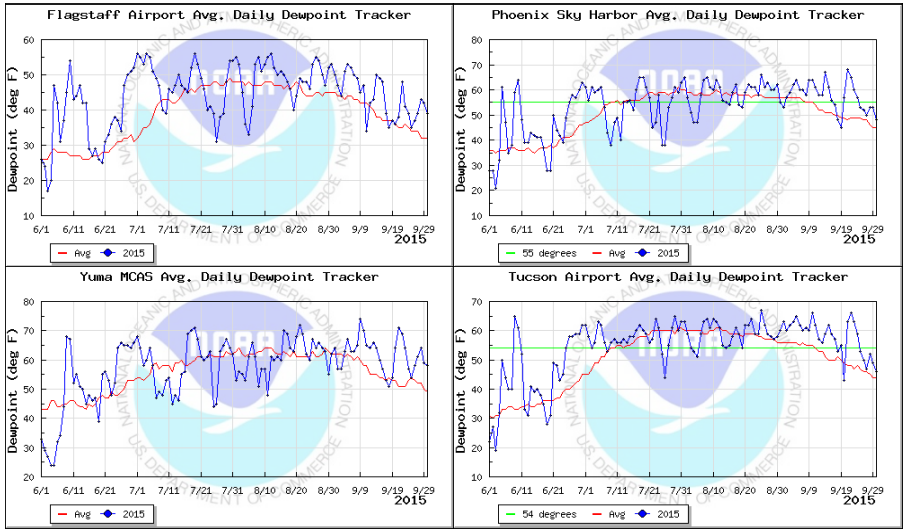


Figure 2: Average Daily Dewpoint Tracker - Flagstaff - Phoenix - Yuma - Tucson

A particularly notable characteristic of the monsoon this year was the persistently above average dewpoint temperatures we saw over the season (Fig. 2). This was likely linked to eastern Pacific tropical storm activity driving moisture into the region. In some cases, this provides a supplement to monsoon precipitation, as we saw this year with Linda, 16-E (and last year with Norbert and Odile). These storms can have intense and spatially variable effects, including increased precipitation and serious flooding, as well as driving up the humidity while adding little additional precipitation.

(cont. on next page)

Online Resources

Figures 3-6
Climate Science Applications Program
http://cals.arizona.edu/climate/

This page has high resolution versions of these maps, along with station level plots across Arizona and New Mexico.

For more information on the monsoon, pleast visit:
http://www.climas.arizona.edu/sw-climate/monsoon

Monsoon Summary (June 15 - Sept 30)

Looking at cumulative totals for the 2015 monsoon, precipitation as a percent of average demonstrates the spatial variability of monsoon precipitation (Figs. 3a–b), while raw precipitation totals show the wide range of normal precipitation totals we see across the Southwest (Figs. 4a–b). These totals can be skewed by a few strong events or even a single strong storm; the percent of days with rain (Figs. 5a–b) highlights the regularity of monsoon precipitation thus far, with much of Arizona and nearly all of New Mexico recording rain events (greater than 0.01 inch) on at least 25 percent of days since June 15. The daily intensity index (Figs. 6a–b) further illustrates the steady nature of most of this monsoon precipitation; higher values indicate much of the rain fell in a single event and lower values indicate more frequent and less intense events.

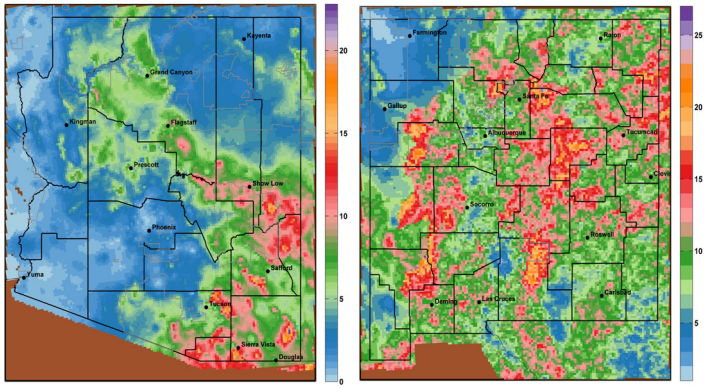


Figure 4a-b: Total Precipitation - Jun 15 - Sep 30

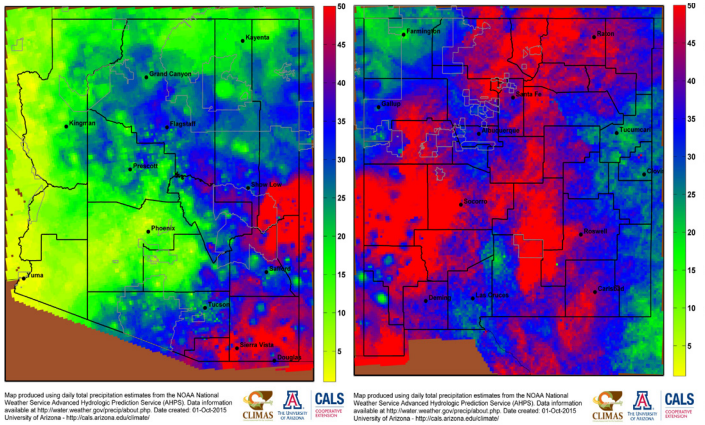


Figure 5a-b: Percent of Days With Rain (>0.01") - Jun 15 - Sep 30

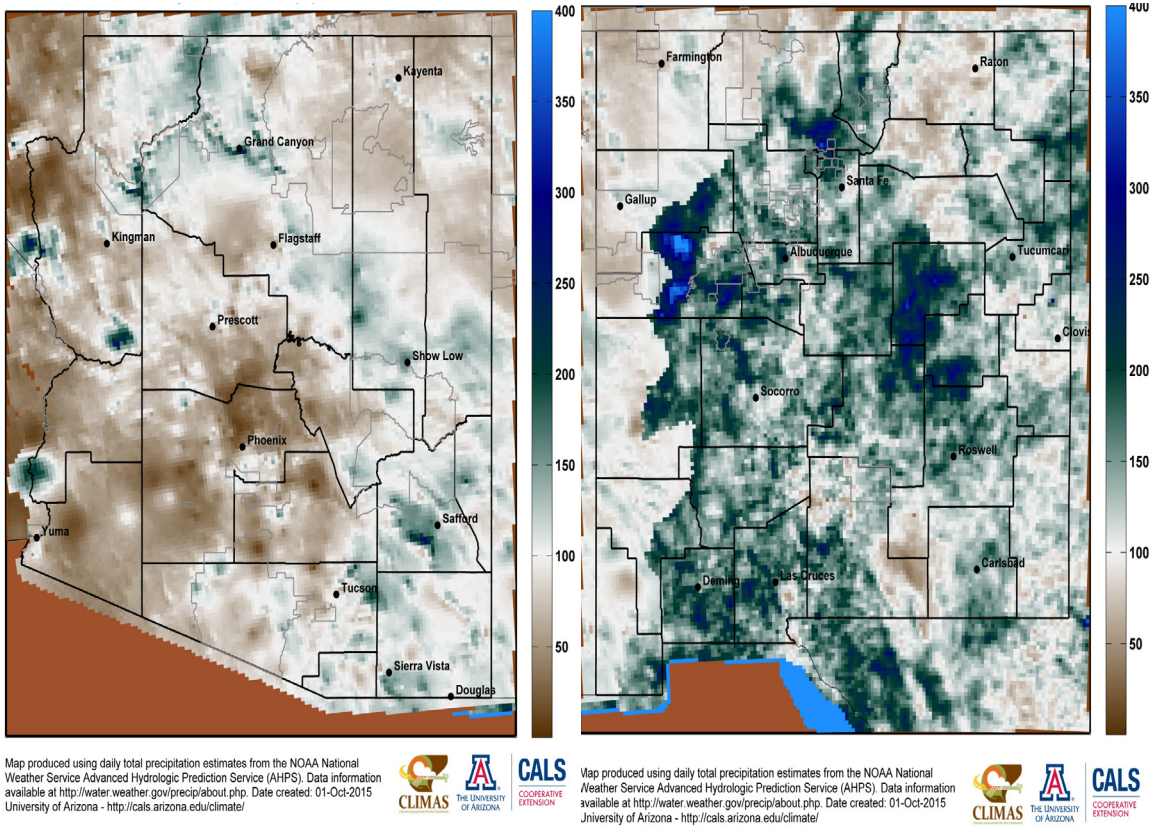


Figure 3a-b: Percent of Average Precipitation - Jun 15 - Sep 30

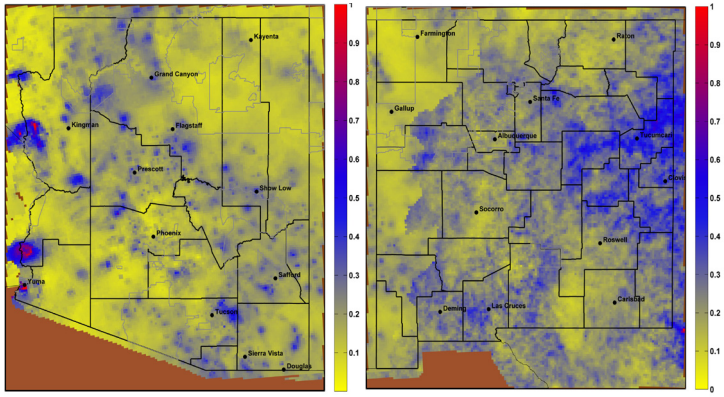


Figure 6a-b: Daily Intensity Index (total precip/days with rain) - Jun 15 - Sep 30

Online Resources

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

Arizona: http://1.usa.gov/19e2BdJ

New Mexico: http://www.wcc.nrcs.usda.gov/cgibin/resv_rpt.pl?state=new_mexico

We are updating our 'max storage' values for numerous NM reservoirs based on conservation storage vs. maximum flood capacity. This alters the percent full calculations, even while 'current storage' numbers are unchanged. 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).

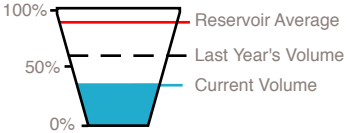
The table details more exactly the current capacity (listed as a percent of maximum storage). Current and maximum storage are given in thousands of acre-feet for each reservoir. One acre-foot is the volume of water sufficient to cover an acre of land to a depth of 1 foot (approximately 325,851 gallons).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

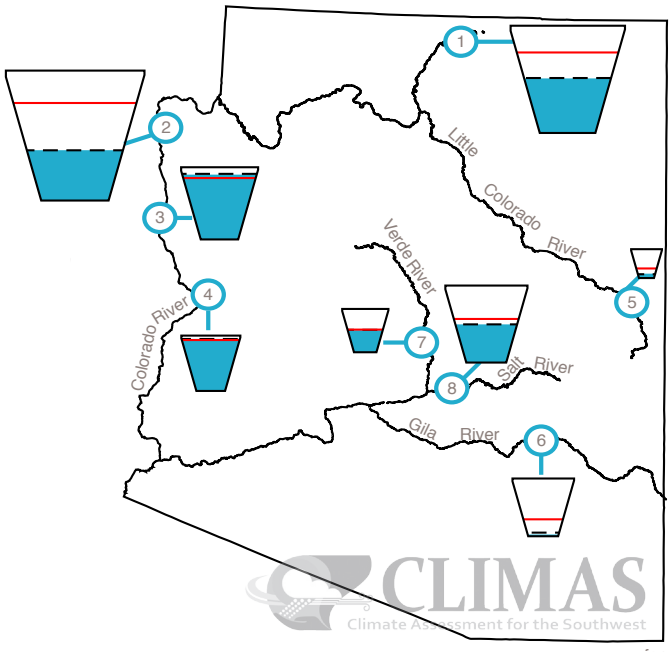
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS).

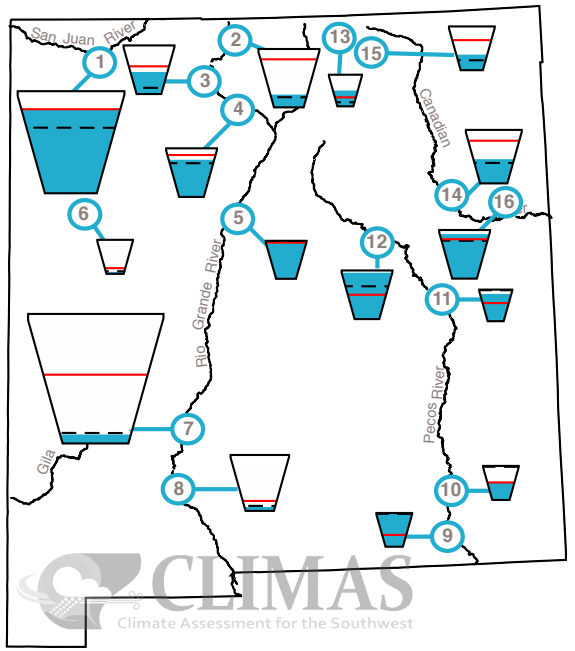
Reservoir Volumes

DATA THROUGH SEPTEMBER 30, 2015

Data Source: National Water and Climate Center, Natural Resources Conservation Service







Reservoir	Capacity	Current Storage*	Max Storage*	One-Month Change in Storage*
1. Lake Powell	51%	12,368.4	24,322.0	-268.5
2. Lake Mead	38%	9,854.0	26,159.0	-17.0
3. Lake Mohave	89%	1,605.8	1,810.0	-68.9
4. Lake Havasu	94%	580.7	619.0	-5.1
5. Lyman	15%	4.5	30.0	0.7
6. San Carlos	2%	14.8	875.0	2.7
7. Verde River System	51%	146.6	287.4	-0.3
8. Salt River System	49%	985.4	2,025.8	-22.3

*KAF: thousands of acre-feet

Reservoir	Capacity	Current Storage*	Max Storage*	One-Month Change in Storage*
1. Navajo	82%	1,391.8	1,696.0	-27.9
2. Heron	21%	84.0	400.0	-34.6
3. El Vado	46%	87.4	190.3	-20.4
4. Abiquiu	76%	141.6	186.8**	20.0
5. Cochiti	94%	47.0	50.0**	-1.2
6. Bluewater	6%	2.2	38.5	-0.1
7. Elephant Butte	8%	168.4	2,195.0	-17.4
8. Caballo	7%	23.8	332.0	-21.8
9. Lake Avalon	113%	5.1	4.5**	0.0
10. Brantley	50%	21.1	42.2**	-30.2
11. Sumner	86%	31.0	102.0**	-2.5
12. Santa Rosa	95%	100.2	105.9**	-1.4
13. Costilla	50%	8.0	16.0	-2.0
14. Conchas	45%	115.0	254.2	-9.6
15. Eagle Nest	36%	29.6	79.0	-1.4
16. Ute Reservoir	92%	183	200	1.0

On the CLIMAS Website

CLIMAS Blog

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http://www.climas.arizona.edu/blog

CLIMAS YouTube Channel

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www.youtube.com/user/UACLIMAS/

CLIMAS Podcasts

Visit our website or iTunes to subscribe to our podcast feed

www.climas.arizona.edu/media/podcasts

El Niño is here, what does that mean for Arizona and New Mexico?

Ben McMahan & Mike Crimmins, Originally published on the CLIMAS blog, Sept 24, 2015

"El Niño" has been all over the news lately, even garnering comparisons to a Godzilla. This characterization is in response to the near-record strength of this El Niño event, which is exciting for climate enthusiasts but leaves most people wondering what a strong El Niño event actually means for Arizona and New Mexico.

Read more: http://www.climas.arizona.edu/blog/el-niño-here…what-exactly-does-mean-arizona-and-new-mexico

Oct 2015 SW Climate Podcast - Monsoon Recap

In this episode of The Southwest Climate Podcast, Mike Crimmins & Zack Guido recap the 2015 monsoon, (and revisit some of their predictions from earlier this summer). In part 1, they give a quick overview of the monsoon, before taking a closer look at the month by month progression, to track the overall season for what stood out (and what was underwhelming). In part 2, they talk about nuances associated with the monsoon, including the impacts of El Niño, and eastern pacific tropical storm activity. They conclude with a discussion of the variable nature of the monsoon, and what makes this such an exciting place to live as we watch the season unfold.

Listen: http://www.climas.arizona.edu/podcast/oct-2015-sw-climate-podcast-monsoon-recap

Sept 2015 SW Climate Podcast - El Niño Super-Podcast

In this edition of the CLIMAS Southwest Climate Podcast, Zack Guido and Mike Crimmins focus specifically on El Niño and what we can expect going into this fall and winter, given the "strong" status of this El Niño event.

Part 1: A look at the El Niño signal, including a look back at what happened in 2014 (and why El Niño didn't start when we thought it would), as well as a look forward for what El Niño might mean regionally and globally. Part 2: A close look at the 97-98 El Niño event, and what happened in the Southwest during the last "strong" El Niño event...Can we expect more of the same? What might be different? Part 3: A look at the El Niño models going into Fall 2015 and Winter 2016 - How certain are we about increased precipitation this winter? When might we see this increase? Any chance for a "boringly average" year, despite the El Niño signal?

Listen: http://www.climas.arizona.edu/podcast/sw-climate-podcast-el-niño-super-podcast

Notes from an Applied Climatologist: Monsoon End Q&A

Mike Crimmins, Originally published on the CLIMAS blog, Sept 29, 2014

How Do We Know When the Monsoon is Over? Across the southwest United States, the start of the summer monsoon season is pretty easy to recognize once you have experienced it firsthand a few times. Typically, one week it's hot and dry, and the next week, it's hot and sticky, but hopefully raining. This is a predictable part of the southwestern summer, and typically happens in late June or early July across Arizona and New Mexico (often first in New Mexico with Arizona trailing just behind). The start is relatively clear cut, but calling an end to the monsoon season is a bit trickier, because there isn't a rapid and clean transition back to some other non-monsoon weather conditions in the fall, and the presence of monsoon breaks can complicate this transition.

Read more: http://www.climas.arizona.edu/blog/notes-applied-climatologist-monsoon-end-qa