Contributors

Ben McMahan
SWCO Editor; Research, Outreach & Assessment Specialist (CLIMAS)

Mike Crimmins
UA Extension Specialist

Stephanie Doster
Institute of the Environment Editor

Dave Dubois
New Mexico State Climatologist

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

Paulina Jenney
Institute of the Environment, Communications Assistant

Nancy J. Selover
Arizona State Climatologist

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

January Southwest Climate Outlook

Precipitation: Over the past 30 days, the cumulative precipitation totals for Arizona and New Mexico were a mix of above- and below-average values (Fig. 1). Thirty-day averages often span wet and dry periods, while the week-to-week totals show considerably more variability. For example, precipitation totals in southern Arizona were buoyed by a series of storms that brought significant rainfall to the southwestern U.S. in the first week of January, which was preceded by a relatively below-average December and followed by an extended dry period in mid-January (see El Niño Tracker on pages 3-4 for more commentary and discussion of recent precipitation trends).

Temperature: December cooled off in much of the Southwest. Most of Arizona recorded normal to below-normal temperatures, while New Mexico was mostly normal to above normal, especially along the eastern half of the state (Fig. 2). Globally, 2015 was the warmest year on record and was among the top five warmest years for many western states (Fig. 3), and was the second warmest year on record for the U.S. overall.

Snowpack and Water Supply: Relatively frequent winter storm activity has brought impressive snowpack levels and snow water equivalent (SWE) percent of normal values to much of the western U.S., including above-normal values across almost all of the basins in Arizona and New Mexico (Fig. 4). Increased winter precipitation is an expected pattern given the current strong El Niño event. Later this spring, we will have a more accurate understanding of El Niño's contribution to winter precipitation and a better sense of how temperature affected patterns of rain and snow and the contributions to water supply (See page 5 for reservoir totals).

Drought: Long-term drought conditions persist across much of central and eastern Arizona along with the western edge of central New Mexico (Fig. 5). Recent runs of average to above-average precipitation have helped mitigate some of the short-term drought conditions, but we are continually reminded that multi-year droughts, such as those we experienced during much of the 21st century, will require multi-year periods to fully recover. El Niño offers hope for additional drought relief, particularly if above-average precipitation over the winter helps saturate soils and build snowpack in the region, boosting reservoir storage during springtime snowmelt runoff events.

El Niño Tracker: We are in the middle of a strong El Niño event forecast to remain in place through Spring 2016. We can expect variable weather throughout the winter season, but we anticipate more winter precipitation events and a higher cumulative total at the end of the cool season (see El Niño Tracker on pages 3-4).

Precipitation & Temperature Forecast: The January 21 NOAA-Climate Prediction Center three month seasonal outlook predicts above-average precipitation for most of the Southwest this winter, with progressively increasing chances of above-average precipitation as you move south (Fig. 6, top). Temperature forecasts are split, with elevated chances for above-average temperatures along the West Coast and the Pacific Northwest, and increased chances for below-average temperatures centered over Texas and and southeastern New Mexico (Fig. 6, bottom).

Tweet Jan SW Climate Outlook

CLICK TO TWEET

Jan2016 @CLIMAS_UA SW Climate Outlook - Climate Summary, El Niño Tracker and Early Season Recap, Reservoir Volumes http://bit.ly/1lAhAJq

January Southwest Climate Outlook

Online Resources

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

Figure 2
NOAA National Centers for Environmental Information
https://www.ncdc.noaa.gov/

Figure 3
High Plains Regional Climate Center - HPRCC
http://www.hprcc.unl.edu/

Figure 4
Western Regional Climate Center
http://www.wrcc.dri.edu/

Figure 5
U.S. Drought Monitor
http://droughtmonitor.unl.edu/

Figure 6
NWS Climate Prediction Center
http://www.cpc.ncep.noaa.gov/

CLIMAS YouTube Channel

Visit our YouTube channel for videos of content pulled from the podcast.

www.youtube.com/user/UACLIMAS/

Podcasts

Visit our website or iTunes to subscribe to our podcast feed.

www.climas.arizona.edu/media/podcasts

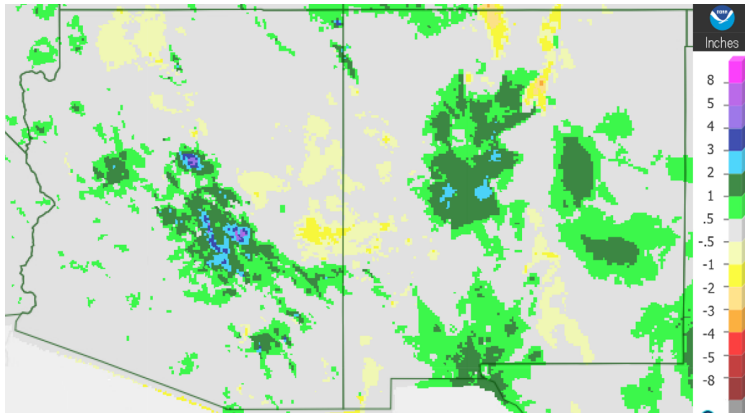


Figure 1: Departure from Normal Precipitation - Past 30 Days

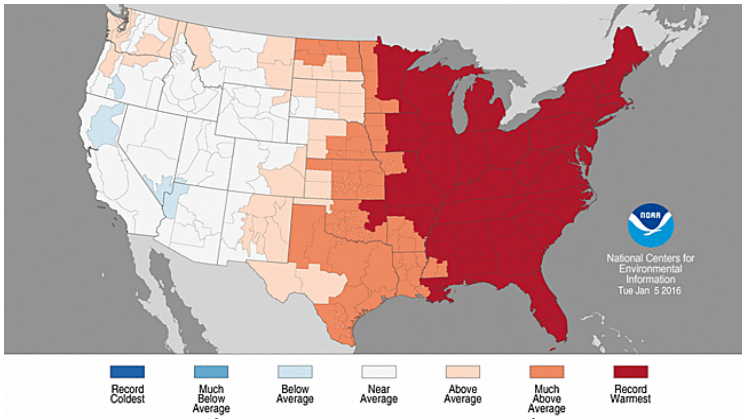


Figure 2: Climate Division Temperature Ranks - Dec 2015

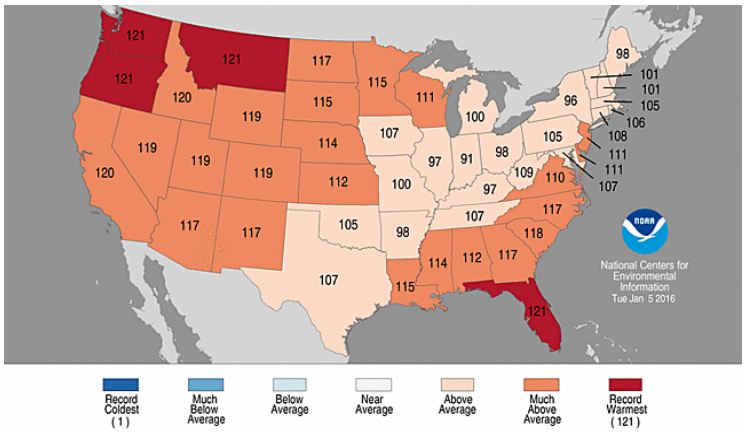


Figure 3: Statewide Temperature Ranks - Jan-Dec 2015

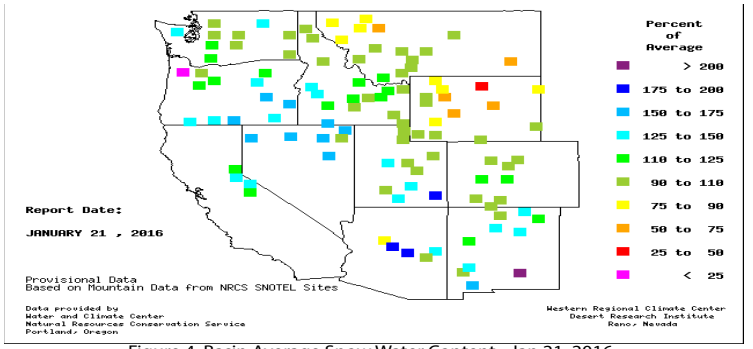


Figure 4: Basin Average Snow Water Content - Jan 21, 2016

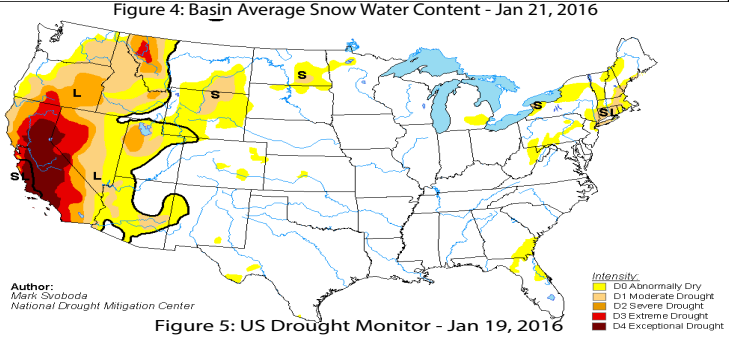


Figure 5: US Drought Monitor - Jan 19, 2016

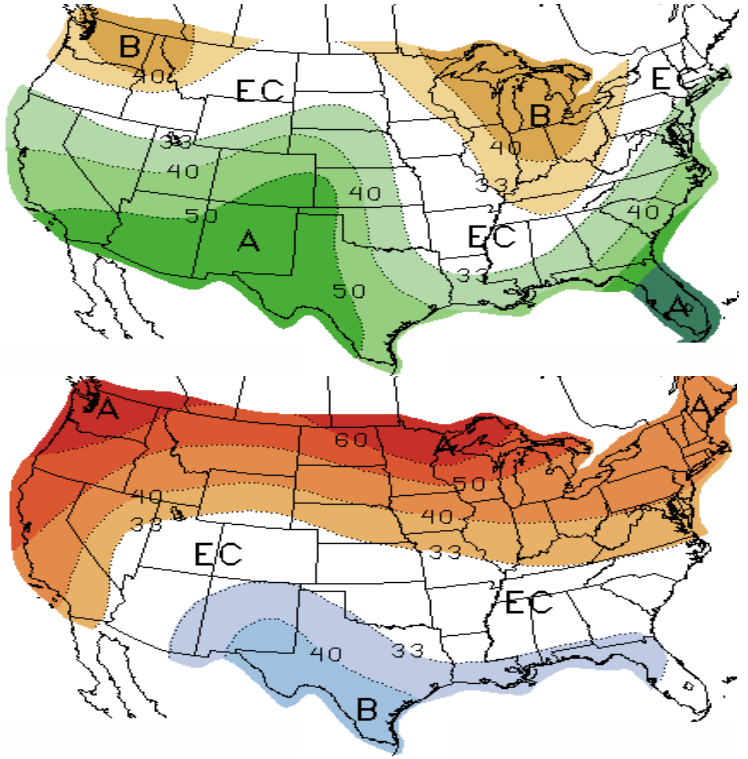


Figure 6: Three-Month Precipitation & Temperature Outlook - Jan 21, 2016

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

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

El Niño 2015-2016

We spent 2014 and the first part of 2015) waiting in anticipation for an El Niño event that was 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. There are numerous impacts we expect to see across the Southwest over 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 things we learned from past events, and what forecast 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 El Niño 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 11th straight month, putting us squarely in the middle of a strong El Niño event that will be among one of the strongest events on record. 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. Models continue to forecast a strong El Niño event that will last through spring 2016, but we are starting to see signs of decline in the overall strength of the event.

On Jan. 12, the Japan Meteorological Agency identified ongoing El Niño conditions as having reached their “mature stage” in the equatorial Pacific in November–December 2015, with likely gradual weakening during the months ahead. On Jan. 14, the NOAA-Climate Prediction Center (CPC) extended its El Niño advisory and said the current atmospheric and oceanic anomalies reflect a strong El Niño that will persist through most of the spring, transitioning to ENSO-neutral by late spring or early summer. The CPC noted, however, that the “exact timing of the transition is difficult to predict.” On Jan. 19, the Australian Bureau of Meteorology maintained its tracker at official El Niño status, with the event likely having peaked and ocean temperatures showing signs of gradual cooling. On Jan. 21, the International Research Institute for Climate and Society (IRI) and CPC forecasts indicated that all oceanic and atmospheric variables were indicative of a strong El Niño event, with consensus centering on strong El Niño conditions that will persist through spring 2016 (Fig. 3). The IRI/CPC briefing also indicated El Niño strength peaked in November–December, but that this was a “broad peak” with a gradual decline and the El Niño event would remain strong through late spring 2016.

(cont. on next page)

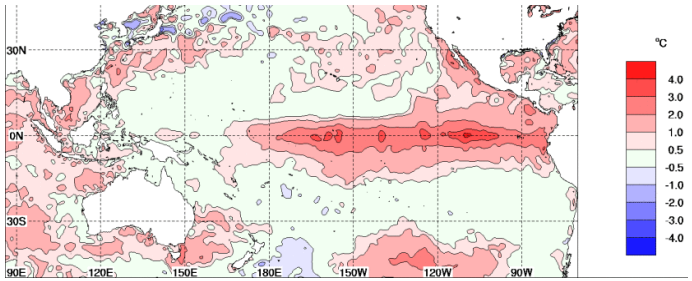


Figure 1: Dec 2015 Sea Surface Temperature (SST) Anomalies

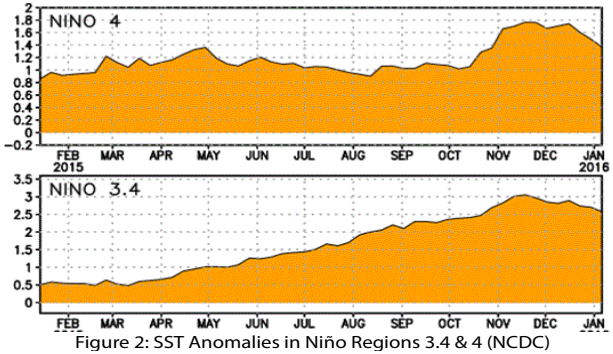


Figure 2: SST Anomalies in Niño Regions 3.4 & 4 (NCDC)

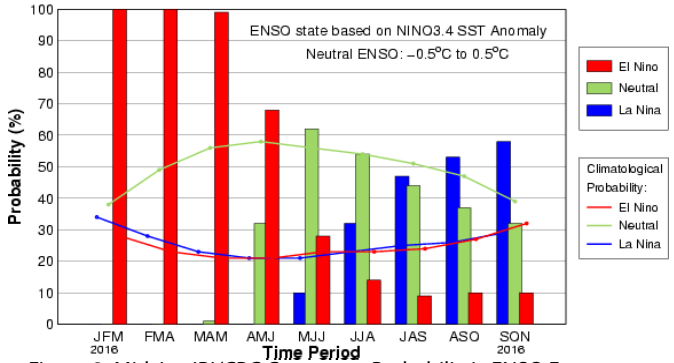


Figure 3: Mid-Jan IRI/CPC Consensus Probabilistic ENSO Forecast

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

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 and summer (Fig. 4).

So what does this mean for the region? Even though forecasts are looking at the eventual decline of the El Niño signals, we are in the middle of a strong El Niño event. For the Southwest, the current seasonal forecasts and past events suggest we should see well above-average cumulative precipitation totals throughout our cool season (October–March), but we should also expect periods of inactivity between storms. Even though the 2015–2016 El Niño event "peaked" in November-December, we see impacts in the Southwest as they lag behind this spike in intensity, which means that we look to late winter and early spring as the most likely times to see increased storm activity associated with the El Niño signal. This doesn't mean we can't or won't see increased activity outside of this window, but the default state for the desert Southwest is dry; even a strong El Niño event can only alter that system so much. We won't be able to fully dissect and judge the 2015–2016 El Niño event until we see just how much rain and snow fell over the entire cool season. Given what we know about past events, our best bets for receiving above-average precipitation will be in February and March, or even April.

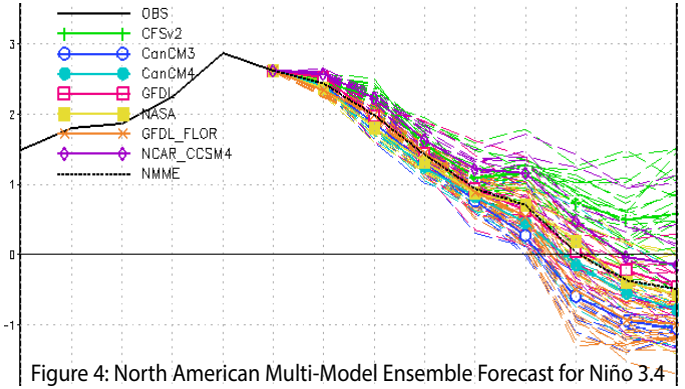


Figure 4: North American Multi-Model Ensemble Forecast for Niño 3.4

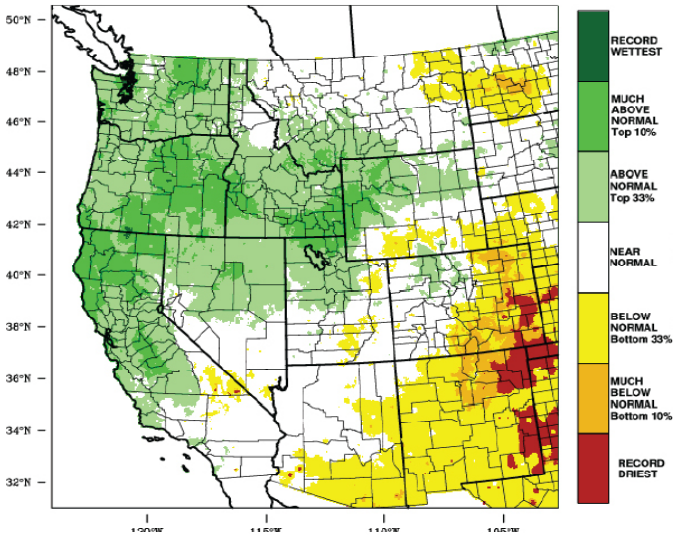


Figure 6: January 1998 Precipitation Percentile - WestWide Drought Tracker

---

Looking at the 1997–1998 event—the strongest El Niño event on record—most of Arizona and New Mexico received below-average rain and snowfall for all of January before returning to normal or above-normal precipitation in February and March (Figs. 5–8).

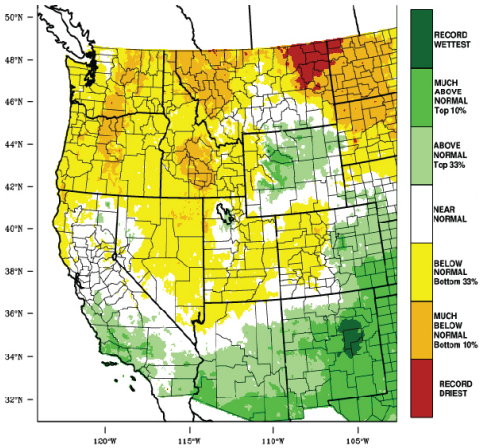


Figure 5: December 1997 Precipitation Percentile - WestWide Drought Tracker

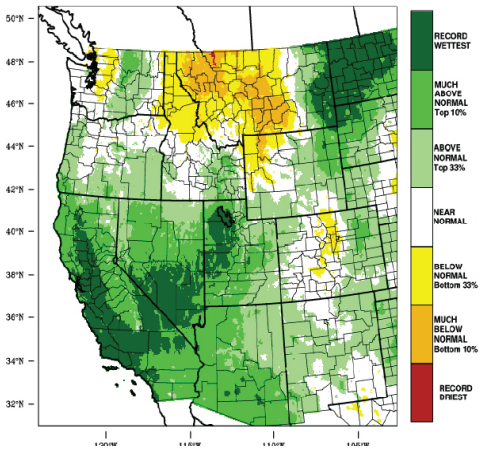


Figure 7: February 1998 Precipitation Percentile - WestWide Drought Tracker

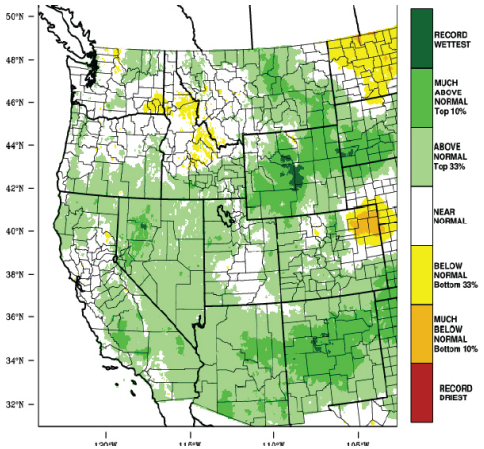


Figure 8: March 1998 Precipitation Percentile - WestWide Drought Tracker

Online Resources

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).

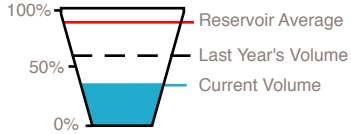
The table details more exactly the current capacity (listed as a percent of maximum storage). Current and maximum storage are given in thousands of acre-feet for each reservoir. One acre-foot is the volume of water sufficient to cover an acre of land to a depth of 1 foot (approximately 325,851 gallons).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

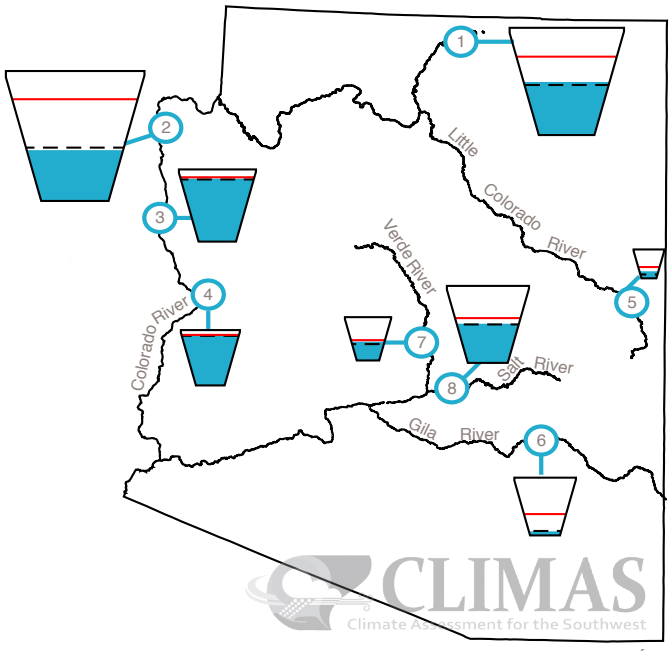
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS).

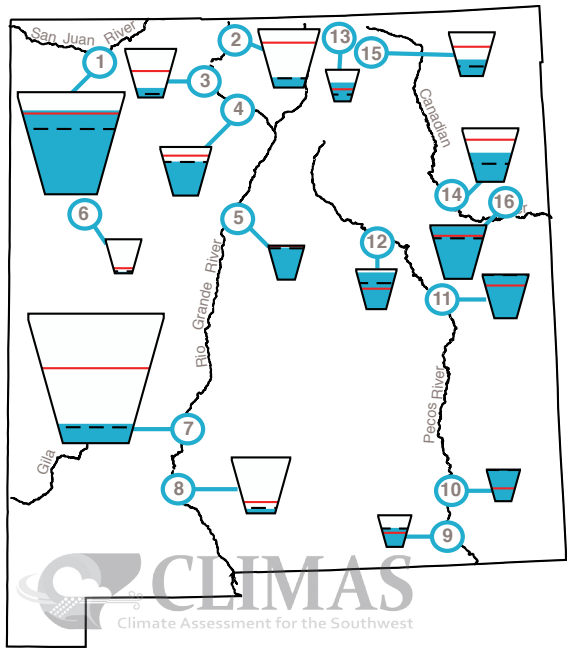
Reservoir Volumes

DATA THROUGH DEC 31, 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	49%	11,812.0	24,322.0	-474.6
2. Lake Mead	39%	10,095.0	26,159.0	230.0
3. Lake Mohave	87%	1,580.3	1,810.0	68.8
4. Lake Havasu	91%	562.6	619.0	-9.2
5. Lyman	24%	7.1	30.0	1.0
6. San Carlos	7%	58.0	875.0	11.9
7. Verde River System	43%	122.4	287.4	-2.2
8. Salt River System	51%	1034.9	2,025.8	26.2

*KAF: thousands of acre-feet

Reservoir	Capacity	Current Storage*	Max Storage*	One-Month Change in Storage*
1. Navajo	82%	1,397.0	1,696.0	-2.5
2. Heron	17%	68.6	400.0	-2.7
3. El Vado	19%	36.5	190.3	-33.6
4. Abiquiu	70%	130.5	186.8**	-4.9
5. Cochiti	94%	46.8	50.0**	0.1
6. Bluewater	5%	2.0	38.5	0.0
7. Elephant Butte	15%	322.5	2,195.0	90.1
8. Caballo	8%	27.7	332.0	1.4
9. Lake Avalon	60%	2.7	4.5**	0.8
10. Brantley	103%	43.6	42.2**	3.6
11. Sumner	121%	43.6	102.0**	3.4
12. Santa Rosa	92%	97.0	105.9**	0.1
13. Costilla	59%	9.4	16.0	0.4
14. Conchas	54%	137.1	254.2	1.1
15. Eagle Nest	38%	29.7	79.0	0.3
16. Ute Reservoir	98%	195	200	0.0

Online Resources

Figure 1
UCAR Climate Data Guide
https://climatedataguide.ucar.edu

Figure 2
WestWide Drought Tracker
http://www.wrcc.dri.edu/

Resources

1) 'Godzilla' El Niño: Unbelievable rain for California, dry winter for Midwest

http://www.latimes.com/local/lanow/la-me-ln-godzilla-el-nino-winter-california-20150821-htmlstory.html

2) El Niño is here…what exactly does that mean for Arizona and New Mexico?

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

3) December El Niño update: phenomenal cosmic powers!

https://www.climate.gov/news-features/blogs/enso/december-el-niño-update-phenomenal-cosmic-powers

4) Notes from an Applied Climatologist: Monsoon End Q&A

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

El Niño Early Season Recap (Oct-Dec 2015)

Mike Crimmins, Associate Professor and Climate Science Extension Specialist Department of Soil, Water and Environmental Science & CLIMAS Prinicipal Investigator

Looking back at Oct-Dec, did observed weather events correspond with expected (El Niño) climate patterns?

January kicked off with a bang, and the much anticipated mega-Godzilla El Niño[1] is upon us. El Niño conditions have been in place for months (Fig. 1), but has this El Niño event been impacting the weather of the Southwest in the ways that we anticipated? Sort of, but not exactly…

This is probably to be expected, as we[2] and others[3] have been saying that no two El Niño events are alike (which means they are hard to compare). In addition, the October-November-December time period is still very early season for El Niño in the Southwest, so it would be premature to judge it too harshly.

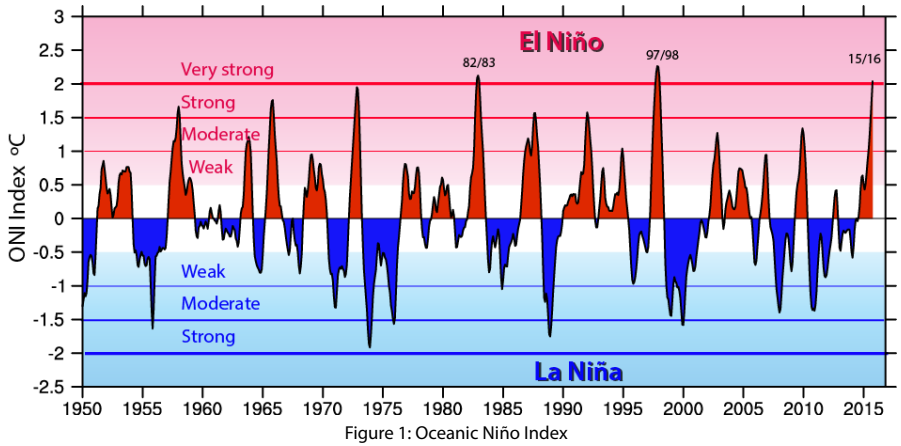


Figure 1: Oceanic Niño Index

First off, October through December is a period of transition for the Southwest[4], a time when we move from our summer monsoon thunderstorm season into a more westerly upper-level circulation pattern, and look expectantly for winter storms to bring precipitation to the region. October is also the time when a tropical storm can either directly or indirectly bring heavy precipitation to the region. Even during a 'normal' year with no El Niño influence, it is a 'noisy' time with lots of moving parts and potential variability, with quite a few dry and wet extremes in the historical record. Long story short, El Niño or not, we expect to see a lot of variability during this transition season, so the larger question is how much does El Niño typically impact this season?

The influence of El Niño during this October–December transition operates through the mechanisms of tropical storm activity and early winter storm tracks, both of which can impact precipitation patterns across the Southwest. Typically, tropical storm activity is enhanced in the east Pacific during strong El Niño events, raising the likelihood of above-average precipitation from these events. In addition, the southward shift in the winter storm track, a hallmark impact of El Niño events, can set up as early as November. Based on this, we largely expected this period to be wetter than average for Arizona and New Mexico and it mostly was (Fig. 2). But when we look a bit more closely, the forces driving this precipitation were a bit unusual and didn't quite fit the typical El Niño-driven patterns.

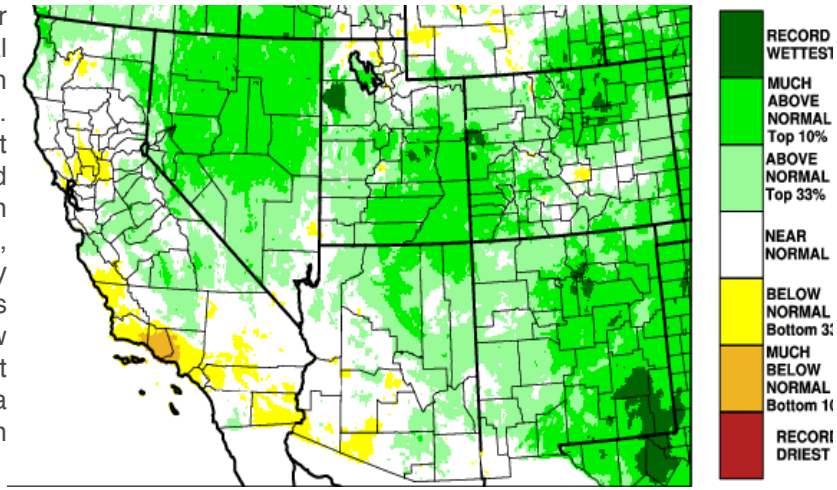


Figure 2: Oct - Dec 2015 Precipitation Percentile

(cont. on next page)

Online Resources

Figures 3-5
High Plains Regional Climate Center
http://www.hprcc.unl.edu/

Figures 6-8
WestWide Drought Tracker
http://www.wrcc.dri.edu/

Resources

5) NOAA Synoptic Discussion - October 2015

https://www.ncdc.noaa.gov/sotc/synoptic/201510

6) NOAA Synoptic Discussion - November 2015

https://www.ncdc.noaa.gov/sotc/synoptic/201511

7) Blizzard Buried Some Dairy Cows in the Snow; 35,000 Die

http://www.nytimes.com/2016/01/06/us/in-west-texas-hundreds-of-dairy-cows-killed-by-blizzard.html

El Niño Early Season Recap (continued from previous page)

For example, a series of cut-off low pressure systems in October wandered across the Southwest (at one point, the same cut-off low visited Arizona twice), picking up abundant tropical moisture and creating widespread precipitation events across Arizona and New Mexico. These cut-off lows formed off of a very busy jet stream pattern across the Pacific Ocean that in part was energized by the tropical storm activity across the basin[5] (see the NOAA discussion). Instead of directly interacting with tropical storms in the east Pacific, El Niño appears to have brought us to above-average precipitation for October in a much more complicated way (Fig. 3).

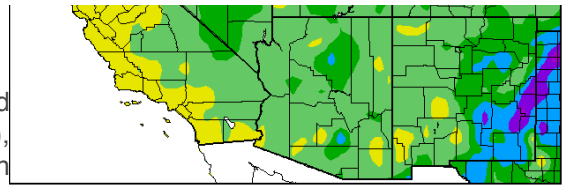


Figure 3: Departure from Normal Precip Oct 2015

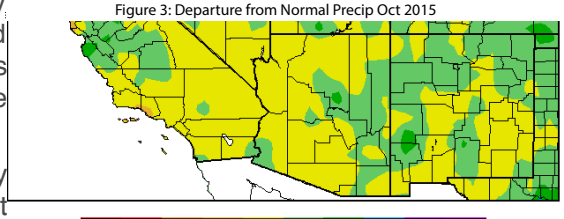


Figure 4: Departure from Normal Precip Nov 2015

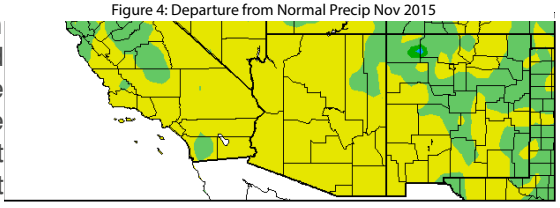


Figure 5: Departure from Normal Precip Dec 2015

A highly amplified jet stream pattern continued into November, again partially driven by tropical storm activity that was absorbed into the jet stream in the west Pacific[6], leaving the Southwest to contend with a busy weather pattern but very little to work with in the way of moisture. A parade of storms marched through the Southwest through the month, but they originated in the Gulf of Alaska and brought very little moisture. Some higher elevation and more northern areas were able to wring out some precipitation with these storm systems, but overall the month was cool and relatively dry for the Southwest (Fig. 4). This was in contrast to the expectation of a much stronger subtropical jet—which was present but south of Arizona and New Mexico—pulling in abundant moisture from lower latitudes.

Similarly, in December, the Southwest saw passing storms and cooler-than-average temperatures but little in the way of precipitation (Fig. 5). New Mexico received higher precipitation totals a bit late in the month when a historic blizzard[7] (compared to a similar snowstorm that hit the region in January of 1983, also a strong El Niño winter,) swept through the area. The final precipitation totals for October–December 2015 across the Southwest are more or less what you would expect for an El Niño year—generally above-average across New Mexico and northern Arizona—and a bit of the unexpected, with drier-than average conditions across parts of western Arizona. But again, maybe that is what we should expect. Two other strong El Niño events (1983, 1997) are very different from each other (Figs. 6-7), illustrating there is considerable variability in the early season El Niño impacts on the Southwest. October–December of 2015 (Fig. 8) establishes itself as yet another flavor of potential precipitation impacts during the fall season across the southwest U.S.

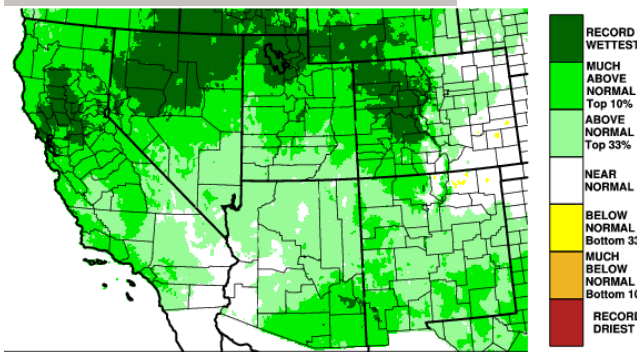


Figure 6: Oct - Dec 1983 Precipitation Percentile

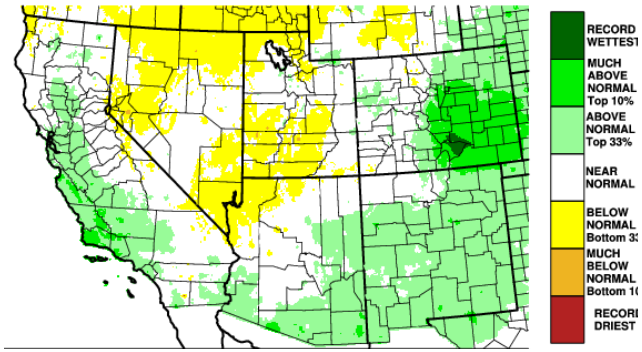


Figure 7: Oct - Dec 1997 Precipitation Percentile

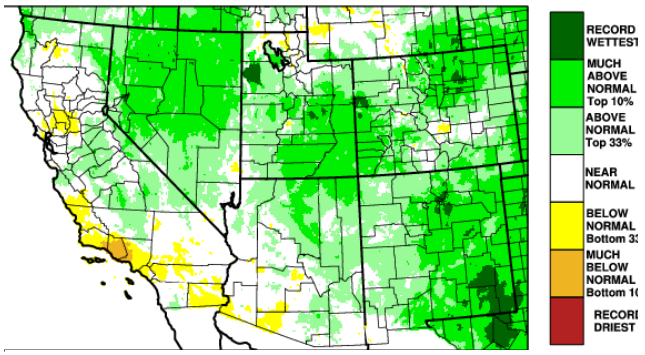


Figure 8: Oct - Dec 2015 Precipitation Percentile

On the CLIMAS Website

CLIMAS Blog

Visit our blog for news, analysis and commentary related to SW climate.

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

CLIMAS YouTube Channel

Visit our YouTube channel for videos of content pulled from the podcast.

www.youtube.com/user/UACLIMAS/

CLIMAS Podcasts

Visit our website or iTunes to subscribe to our podcast feed.

www.climas.arizona.edu/media/podcasts

Introducing the 2016 CLIMAS Climate and Society Graduate Fellows

The Climate & Society Graduate Fellows Program supports University of Arizona graduate students whose work connects climate research and decision making. The program is made possible by support from the Climate Assessment for the Southwest (CLIMAS), the International Research Applications Program (IRAP), and the UA Office for Research and Discovery. Fellows receive $5,000 and guidance from members of the CLIMAS research team for one year.

The program's main objective is to train a group of students to cross the traditional boundaries of academic research into use-inspired science and applied research. While CLIMAS research generally occurs in the Southwest U.S., the Fellows program allows students to work anywhere in the world. Fellows' projects may follow two tracks. Students who want to conduct collaborative research may use their funding for use-inspired projects. Students who have conducted climate research and want to communicate their findings to audiences outside of academia may use their funding for outreach. Fellows may also use their funding for a combination of the two tracks.The 2016 Climate Assessment for the Southwest (CLIMAS) Climate & Society Graduate Fellows are:

Saleh Ahmed - Developing a Community Hub for Climate Innovations in Southwest Coastal Bangladesh

Schuyler Chew - Collaborative Outreach and Climate Adaptation Planning with the Pyramid Lake Paiute Tribe

Stina Janssen - Solar Sovereignty: use-inspired collaborative research for affordable off-grid solar on the Navajo Nation

Sarah Kelly-Richards - Outreach for Small Hydropower Governance in Chile

Joy Liu - Dryland Conservation in China: Local Incentives Drive Collaborative Action on Regional Climate Adaptation

For more details on the fellowship program, visit:

http://www.climas.arizona.edu/education/fellowship-program

CLIMAS Southwest Climate Podcast

Dec 2015 SW Climate Podcast - El Niño in Full Swing

In the December episode of the CLIMAS Southwest Climate Podcast, Mike Crimmins and Zack Guido discuss the difficulty of characterizing a climate phenomenon (in this case, El Niño) on a weather time scale, which is made difficult by the highly variable transition season we see in the Southwest in October and November. This difficulty is especially salient as media, the general public, and climate scientists are all hungry for explanations as to whether day to day events fit into larger climate patterns (i.e. is this an El NIño related impact or not!?). They also go over the recent events of October, November, and early December, before looking forward at what the seasonal forecasts suggest is likely in store for this winter (Hint: All signs still point to a wetter than average winter!).

Listen: http://climas.arizona.edu/podcast/dec-2015-climas-sw-climate-podcast-el-niño-full-swing-and-fall-recap