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April Southwest Climate Outlook

Precipitation & Temperature: Over the past 30 days, above-average temperatures and below-average precipitation continued across most of the Southwest. This pattern was in place for the last 90 days (Fig. 1), due in large part to a ridge of high pressure that diverted moisture away from the region and helped keep temperatures high and humidity low. March 2016 precipitation totals were much below average or even record dry, in most of Arizona and New Mexico (Fig. 2a), while temperatures were among the 10 warmest for the period in each state (Fig. 2b). These precipitation patterns are particularly unexpected, as a strong El Niño is associated with increased chance of above-average precipitation.

Drought, Snowpack and Water Supply: Long-term drought persists across the Southwest, and warm and dry weather has further exacerbated regional drought (Fig. 3). There was some hope that a strong El Niño might help ameliorate drought conditions. Instead, winter precipitation patterns look more like La Niña than El Niño, and water year precipitation, along with snowpack and reservoir storage, is unexpectedly average to below-average in much of the region. Early April storms provided a small boost to snowpack and water supply, but winter was dominated by above-average temperatures and below-average precipitation, which contributed to reduced snowpack across the region. Snow water equivalent (SWE) percent of normal values are well below average in Arizona and southern New Mexico (0 to 50 percent of normal) (Fig. 4), while northern New Mexico and much of the western United States are closer to normal (50 to 110 percent).

El Niño Tracker: This El Niño event is one of the strongest events ever recorded, but its strength is waning and seasonal outlooks forecast a transition to neutral conditions by summer and possibly to La Niña by fall. The strength of the event set high expectations, with hopes that a wet winter would mitigate some of the drought conditions in the Southwest. Six-month cool seasonal totals (Oct–Mar) are disappointingly average or slightly below average and were buoyed by a few strong events interspersed between mostly warmer- and drier-than-average conditions. Paradoxically, regional precipitation patterns more closely reflect those often seen in La Niña years, even though the atmospheric and oceanic conditions were clearly El Niño in origin (See El Niño Tracker and Recap on pp. 3-5).

Environmental Health and Safety: The wildflower season has been incredible this year, and also highlights the extent to which allergy sufferers are exposed to a diversity of pollen in the Southwest. Dust also remains a primary concern in terms of human health and public safety, especially as warm, dry, and windy conditions have increased the number and extent of dust events. Wildfire season is underway, and while the early April precipitation event may have tamped down fire risk temporarily, fine fuel growth from a wet fall combined with dry conditions this winter have contributed to above-normal wildland fire risk for May and into summer (Fig. 5).

Precipitation and Temperature Forecast: The March 17 NOAA-Climate Prediction Center three-month seasonal outlook calls for increased chances of above-average precipitation for most of the Southwest (Fig. 6, top) and increased chances of above-average temperatures across most of the western United States (Fig. 6, bottom).

Tweet Apr SW Climate Outlook

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APR2016 @CLIMAS_UA SW Climate Outlook, Drought, Wildfire, El Niño Recap & what happened this winter in the SW? http://bit.ly/1qFCzxp

April Southwest Climate Outlook

Online Resources

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

Figure 2
NOAA National Center for Environmental Information
http://www.ncdc.noaa.gov/

Figure 3
U.S. Drought Monitor
http://droughtmonitor.unl.edu/

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

Figure 5
National Interagency Fire Center
http://www.nifc.gov/

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

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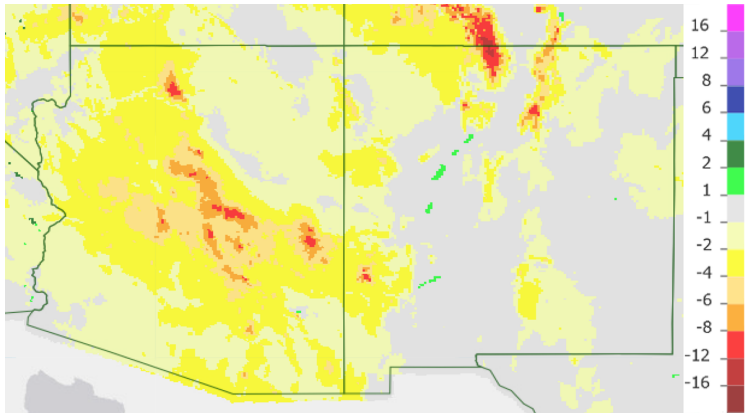

Figure 1: Departure from Normal Precipitation - Past 90 Days

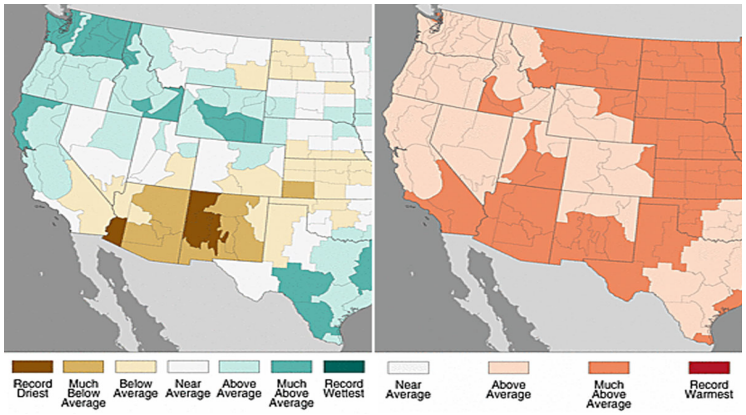

Figure 2: March 2016 Precipitation (a) & Temperature Ranks (b)

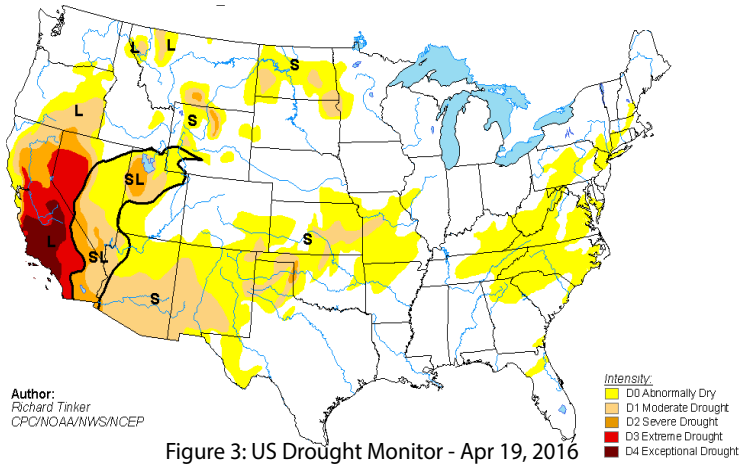

Figure 3: US Drought Monitor - Apr 19, 2016

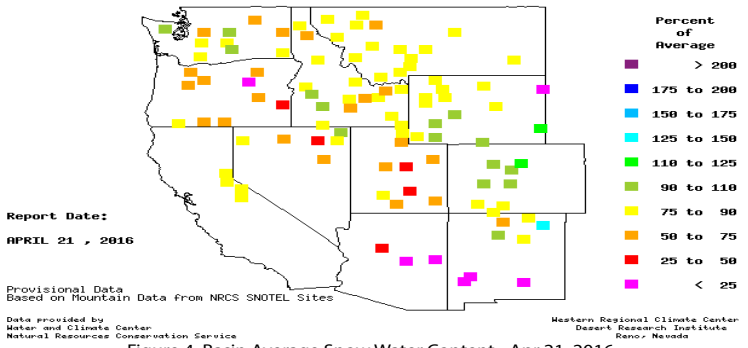

Figure 4: Basin Average Snow Water Content - Apr 21, 2016

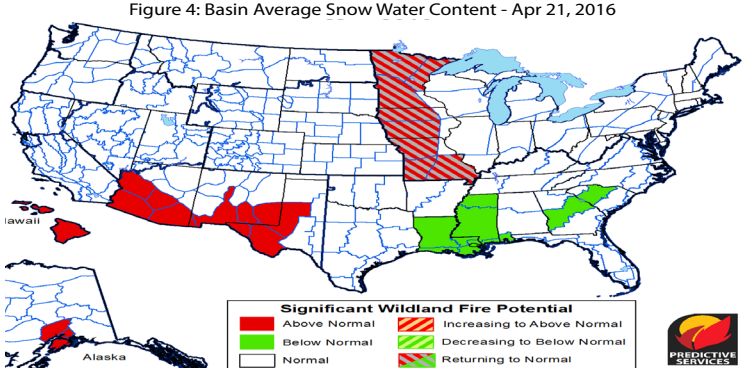

Figure 5: Significant Wildland Fire Potential Outlook - May 2016

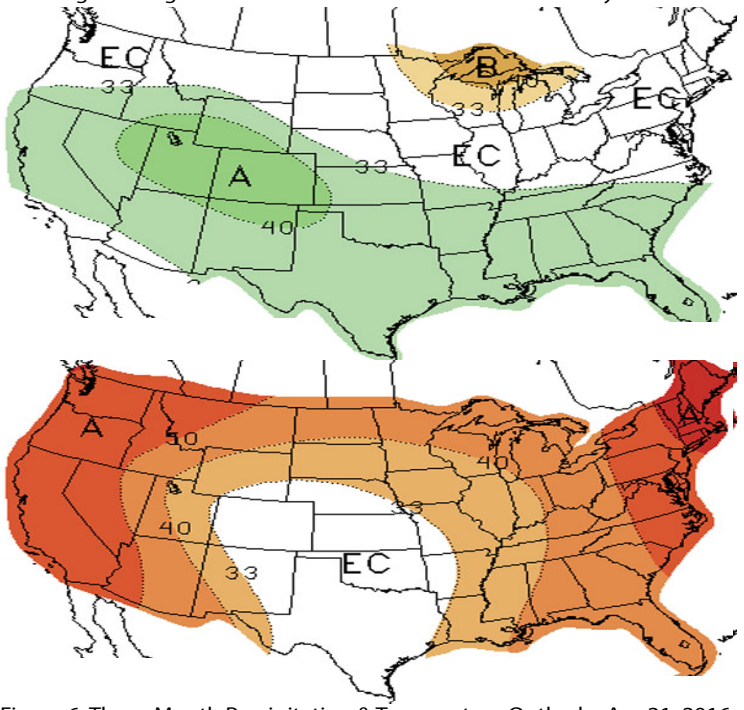

Figure 6: Three-Month Precipitation & Temperature Outlook - Apr 21, 2016

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 strongest 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 it has been going strong for months, with most forecasts indicating that the event is currently in active. We have been aggregating 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, and we will continue to discuss this event, based on what we learned and how it affected the Southwest.

2015–2016 El Niño Tracker

El Niño conditions continued for a 14th straight month, but the peak intensity of this event has passed, based on sea surface temperatures and atmospheric indicators of El Niño. Monitoring and forecast discussions emphasize declining sea surface temperature (SST) anomalies (Figs. 1–2); a decline in convective activity, especially in the eastern Pacific; and weakening wind anomalies. Forecasts emphasize this event will continue through late spring or early summer before returning to ENSO-neutral status, and there is an increasing possibility of La Niña conditions by mid- to late 2016. We are in the middle of the so-called spring predictability barrier, so while this El Niño event is certainly on the way out, there remains considerable model and forecast uncertainty regarding the chances of La Niña or neutral conditions.

On April 11, the Japan Meteorological Agency identified ongoing El Niño conditions that were actively decaying and were expected to weaken to neutral conditions by early summer, with a greater chance of switching to La Niña than remaining ENSO-neutral. On April 12, the Australian Bureau of Meteorology switched its tracker from El Niño to La Niña watch status, noting that while ongoing El Niño conditions were likely to remain for the rest of spring and early summer, they are in active decline. The Bureau also noted the increasing likelihood of La Niña conditions by mid to late 2016. On April 14, the NOAA-Climate Prediction Center (CPC) extended its El Niño Advisory, but added a La Niña Watch. They identified current atmospheric and oceanic anomalies as reflecting an El Niño likely to persist through late spring before transitioning to ENSO-neutral conditions in late spring or early summer. The CPC also identified an increasing chance of a transition to La Niña conditions in late 2016. On April 21, the International Research Institute for Climate and Society (IRI) and CPC forecasts described a quickly weakening El Niño event, with La Niña conditions increasingly likely by late summer (Fig. 3).

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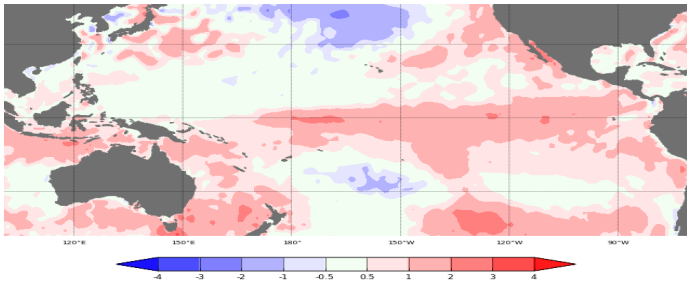

Figure 1: Mar 2016 Sea Surface Temperature (SST) Anomalies

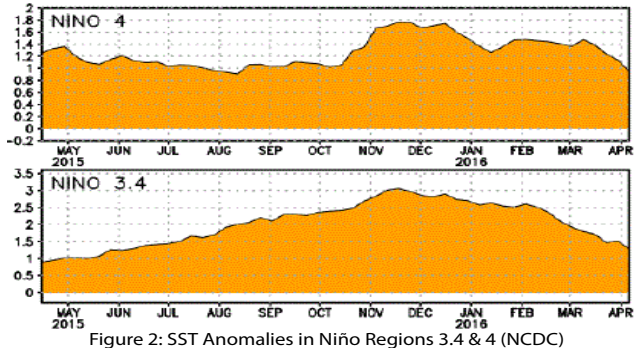

Figure 2: SST Anomalies in Niño Regions 3.4 & 4 (NCDC)

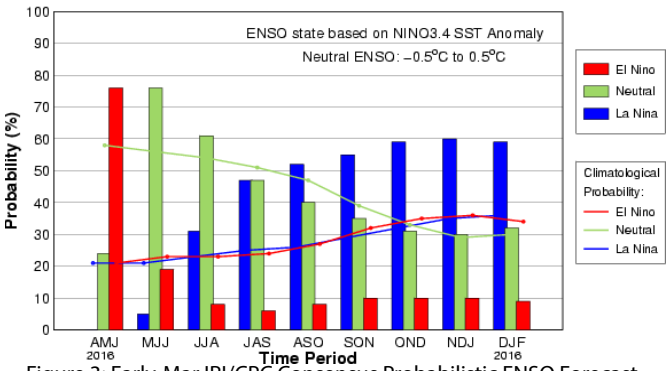

Figure 3: Early-Mar IRI/CPC Consensus Probabilistic ENSO Forecast

Online Resources

Figure 4
NOAA - Climate Prediction Center
http://www.cpc.ncep.noaa.gov/

Figures 5
International Research Institute for Climate & Society
http://iri.columbia.edu/

Figures 6
High Plains Regional Climate Center
http://hprcc.unl.edu

Next month's issue will include a comprehensive recap of the 2015–2016 El Niño, but for now a quick look at seasonal totals, and how these totals were achieved, gives a sense of the performance of this El Niño event compared to expectations.

El Niño

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

2015-2016 El Niño Tracker (continued)

The North American multi-model ensemble shows the current decline from strong to moderate status, as well as the likelihood of neutral status by late spring or early summer, with La Niña conditions likely by late summer (Fig. 4).

While this El Niño event is not over, it is in decline. Globally, there remains the possibility of El Niño-related impacts (Fig. 5), but as we enter our dry season, there is limited time and opportunity remaining for additional precipitation events of significance in the southwestern United States.

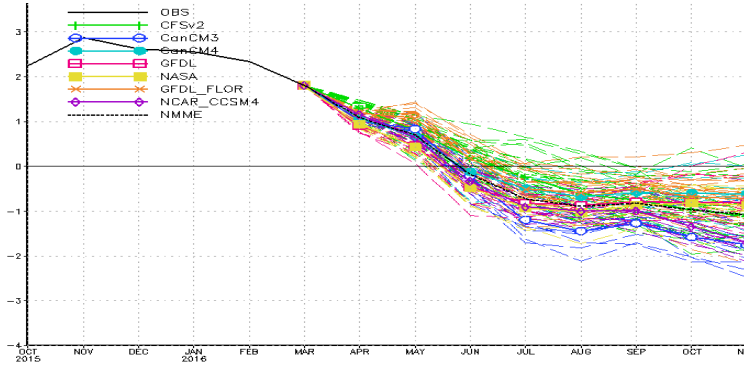

Figure 4: North American Multi-Model Ensemble Forecast for Niño 3.4

El Niño 2015-2016 - Preliminary Recap

Cool season precipitation totals (Oct–Mar) are one metric to evaluate this El Niño event, and they demonstrate that much of the region recorded below-average to near-average precipitation during this period (Fig. 6). A problem with cumulative totals is that a few heavy precipitation events can skew characterizations and combine very different events into the same cluster, masking the impact of a few intense storm events, for example, versus extended periods of gradual precipitation that produce the same overall precipitation totals. During the El Niño event of 2015–2016, a close look at cumulative plots reveals clusters of key events that help illustrate the difficulty associated with scoring El Niño events.

Between October 2015 and March 2016, three main periods of precipitation activity contributed to the seasonal totals for many locations in the Southwest.

The first period was in October, when a number of late-season eastern Pacific tropical storms brought increased precipitation activity to the Southwest by enhancing nearby moisture. A series of cutoff low pressure systems, one visiting the southwestern U.S. twice, brought several rounds of rainfall. Increased eastern Pacific tropical storm activity is a defining characteristic of El Niño events, and these contributions certainly count when tallying precipitation totals. They are not the primary precipitation increases expected during an El Niño event. Instead, increases in winter precipitation are the primary characteristic commonly associated with increased El Niño-related storm activity.

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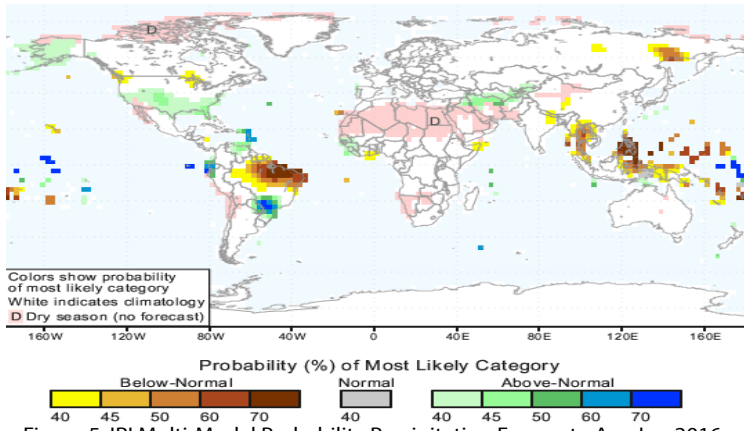


Figure 5: IRI Multi-Model Probability Precipitation Forecast - Apr-Jun 2016

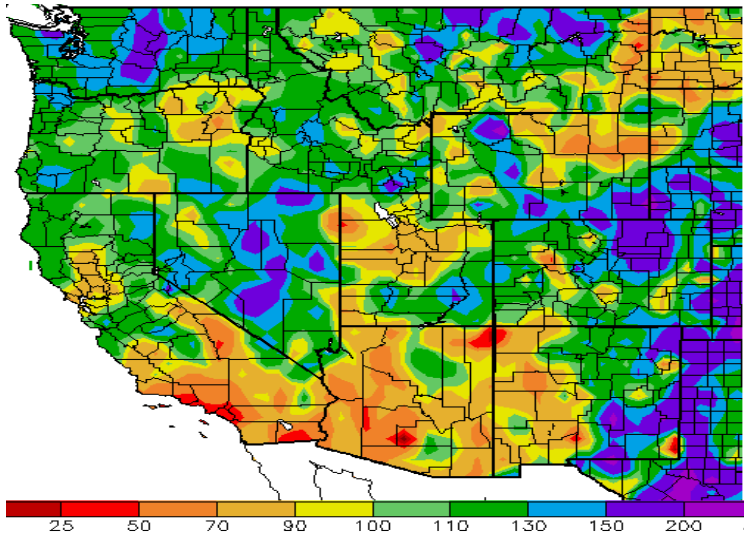


Figure 6: Percent of Normal Precipitation - Oct 1 - Apr 20, 2016

Online Resources

Figure 7
NOAA - Climate.gov
https://www.climate.gov/

Figure 8
Climate Science Applications Program
http://cals.arizona.edu/climate/

El Niño

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

The second period of increased activity began in early January, when a number of precipitation events passed through the Southwest in quick succession. These events reflected a more typical winter El Niño pattern, with a straightened and strengthened southward displaced jet stream channeling moisture into the Southwest from west to east (Fig. 7), and forecasters anticipated that the Southwest would experience more precipitation events similar to this one. This pattern did not repeat, however, as a ridge of high pressure set up and limited the influx of additional moisture into the Southwest (See sidebar). The following months, into early April, were warmer and drier than average, even for a normal year, and especially dry considering the expectations that were set by anticipated effects of a strong El Niño event.

The third period of increased activity was during early April, when a surge of moisture brought a number of storms to the Southwest and bumped up the cool season cumulative precipitation totals. The moisture from these systems was a welcome bookend to the season, as it gave a small boost to regional snowpack and reservoir water storage and helped mitigate some of the emergent fire risk conditions, albeit temporarily. The conditions that led to this wet period were not necessarily what we expect from a typical El Niño pattern, where we might see a series of winter storms riding in on a strong subtropical jet. This active weather period was due to a very slow moving low pressure system (not all that unlike the cutoff low activity in fall 2015) that trudged across the Southwest over about a week helping to steer very warm and moist air across the region. The high amounts of atmospheric moisture created a favorable environment for thunderstorm activity, with several active rounds of storms with lightning and locally heavy rain.

So what happened? The aforementioned ridge of high pressure is one of the major reasons why the southwestern United States and Arizona in particular, has not seen the precipitation frequency or intensity that was forecast in seasonal outlooks. Long-term forecasts and projections were dependent on the influence of a strong El Niño signal at a climate time scale (i.e., how these events cluster over years or decades), but these same forecasts had no way to anticipate a persistent high pressure ridge operating at a weather time scale (i.e., days or weeks) that could knock the precipitation signal out of alignment for weeks on end, at the very time when we were most likely to see El Niño related impacts. In the end, cumulative precipitation totals were lower than expected across much of the Southwest. These results are well within the range of variability of a typical ENSO-neutral winter, but represent a serious outlier from the expected range of outcomes of a strong El Niño (Fig. 8).

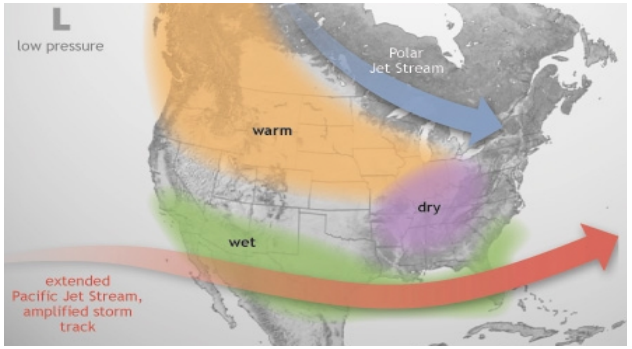


Figure 7: Wintertime El NIño Pattern

This El Niño looks like La Niña?!?

Jet stream patterns that diverted moisture away from the Southwest led to well above-average precipitation in the coastal northwestern United States and northern California, even while the Southwest was drier than normal. This pattern more closely aligns with La Niña conditions, even though the oceanic and atmospheric conditions were still clearly indicative of El Niño. Rather than a mismatch of ENSO signals, this simply reflected the fact that the effects of this high pressure ridge occurred at an especially inopportune time in terms of southwestern climate patterns. The ridge limited the opportunity for El Niño-associated storms during much of the most active season for precipitation events in the southwestern U.S. The region is already characterized by relatively dry conditions in a normal year, so any sub-seasonal event that limits the opportunities for precipitation will cut into seasonal totals in a significant way, as 2016 to date clearly demonstrates.

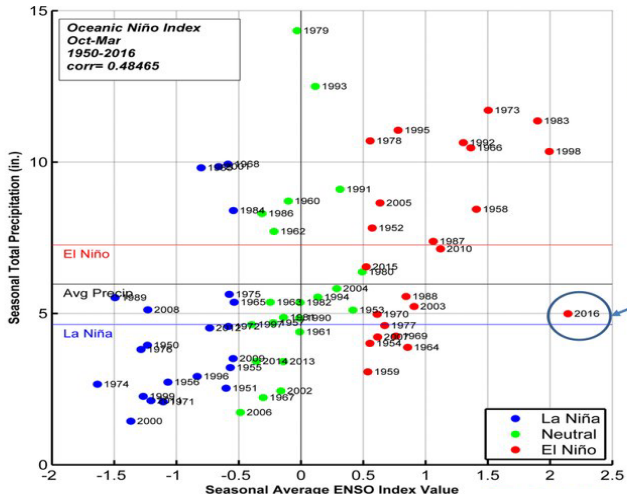


Figure 8: Arizona Climate Division 7 - ENSO vs. Precipitation

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 updated our 'max storage' values for numerous NM reservoirs based on conservation storage vs. maximum flood capacity. This altered 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).

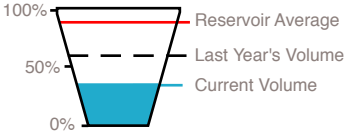
The table details more exactly the current capacity (listed as a percent of maximum storage). Current and maximum storage are given in thousands of acre-feet for each reservoir. One acre-foot is the volume of water sufficient to cover an acre of land to a depth of 1 foot (approximately 325,851 gallons).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

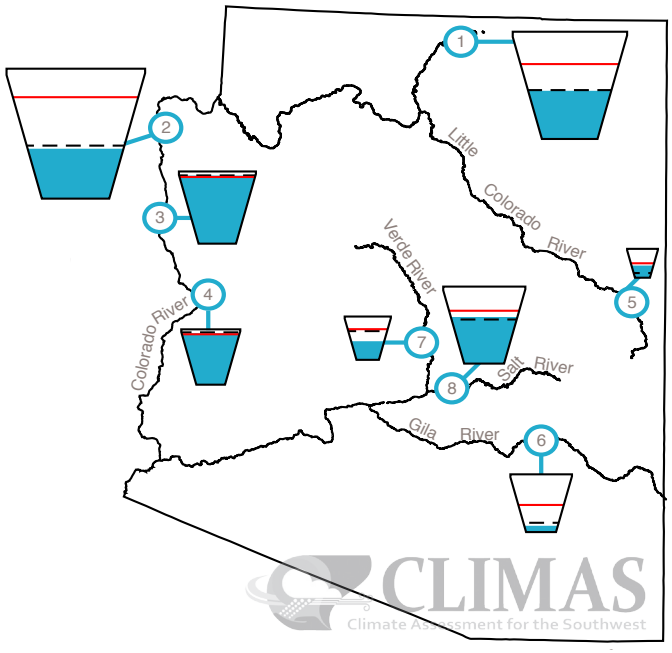
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS).

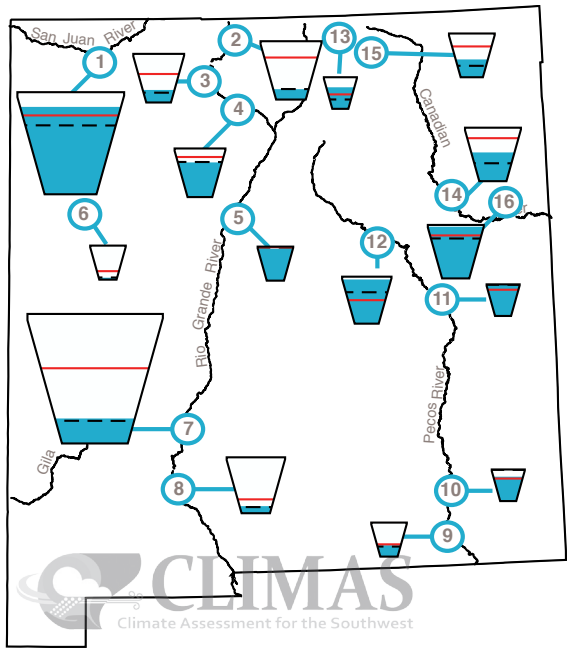
Reservoir Volumes

DATA THROUGH MAR 31, 2016

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	45%	11,007.0	24,322.0	-222.1
2. Lake Mead	38%	10,034.0	26,159.0	-326.0
3. Lake Mohave	94%	1,707.0	1,810.0	60.0
4. Lake Havasu	92%	570.9	619.0	16.8
5. Lyman	42%	12.5	30.0	2.1
6. San Carlos	11%	99.9	875.0	-8.7
7. Verde River System	43%	123.0	287.4	-25.1
8. Salt River System	60%	1,207.4	2,025.8	42.9

*KAF: thousands of acre-feet

Reservoir	Capacity	Current Storage*	Max Storage*	One-Month Change in Storage*
1. Navajo	85%	1,440.6	1,696.0	35.9
2. Heron	18%	73.4	400.0	2.3
3. El Vado	25%	48.3	190.3	13.1
4. Abiquiu	71%	133.4	186.8**	1.0
5. Cochiti	94%	46.8	50.0**	0.4
6. Bluewater	5%	2.1	38.5	0.0
7. Elephant Butte	19%	407.3	2,195.0	6.5
8. Caballo	12%	39.8	332.0	9.0
9. Lake Avalon	33%	1.5	4.5**	-2.9
10. Brantley	77%	32.5	42.2**	-1.0
11. Sumner	119%	42.8	102.0**	-3.3
12. Santa Rosa	94%	99.9	105.9**	2.2
13. Costilla	68%	10.8	16.0	0.5
14. Conchas	54%	137.0	254.2	-2.1
15. Eagle Nest	41%	32.3	79.0	0.9
16. Ute Reservoir	96%	192	200	-2.0

On the CLIMAS Website

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Rio Grande|Bravo

CLIMATE IMPACTS & OUTLOOK

The Rio Grande–Bravo Climate Impacts & Outlook is a monthly product that provides timely climate, weather, and impacts information to stakeholders, researchers, and other interested parties in the Rio Grande–Bravo Basin region of New Mexico, Texas, and Mexico. Each edition recaps conditions over the previous months, including notable events, and then shows forecasts for the next three months for temperature, precipitation, and fire conditions.

The outlook is a product of the North American Climate Services Partnership (NACSP), an innovative trilateral partnership between the U.S., Mexico and Canada. This partnership was established to respond to an increasing demand for accessible and timely scientific data and information in order to make informed decisions and build resilience in our communities. CLIMAS is an active participant in the NACSP Rio Grande-Rio Bravo Regional Pilot Area. CLIMAS co-produces the Rio Grande–Bravo Climate Impacts & Outlook with NACSP partners, and is one of several partners hosting the outlook.

Read more at: http://www.climas.arizona.edu/rgbo

CLIMAS Southwest Climate Podcast
Apr 2016 - An Exceptional El Niño - For all the "Wrong" Reasons?

In the early April edition of the CLIMAS Southwest Climate Podcast, Mike Crimmins and Zack Guido look back at our exceptional El Niño event, which may be standing out for all the wrong reasons - especially in the Southwest. They discuss the anomalously warm and dry conditions the Southwest has experienced since early January; and put these conditions into context regarding our expectations in a strong El Niño year, what might be driving these patterns (and the moisture away from us), and just where that moisture has gone. They also discuss the similarities of the current precipitation pattern to La Niña (i.e. dry in the Southwest and wet in the Northwest) but highlight how this event is very different from La Niña associated atmospheric patterns (even if the precipitation patterns feel like a La Niña year). They also point out that while we're not in a La Niña yet..but forecasts call for much higher chances of a swing to La Niña by fall of this year. They also look forward to the rest of the spring, including the last gasp of moisture the second week of April, and what this underwhelming El Niño might mean for regional drought, snowpack, and wildfire conditions.

Listen: http://www.climas.arizona.edu/podcast/apr-2016-climas-sw-climate-podcast-exceptional-el-niño-all-wrong-reasons

On the Web
Mrs. Green's World - El Nino: Impact in the Southwest & Our World

Mike Crimmins & Zack Guido appeared on Mrs. Green's world to talk El Niño. Broadcast 4/16/2016 - Just what is El Nino? What are its impacts on the Southwest and what are some "events" that might be of interest to all of us? This show made possible due to the generous support of The University of Arizona, Institute of the Environment.

Listen: http://www.mrsgreensworld.com/2016/04/16/el-nino-impact-in-the-southwest-our-world-2/