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October Southwest Climate Outlook

Precipitation: Persistent tropical storm activity in the past 30 days boosted precipitation, even while the monsoon was waning. Above-average precipitation was recorded in the southern half of Arizona and New Mexico during this time period, while the northern portions of the region saw more inconsistent (and often below-average) precipitation totals.

Temperature: Most of Arizona and New Mexico were warmer than average in the past 30 days, especially the northern half of both states. Temperatures in the southern half were more variable, as tropical storms brought pulses of cooler and wetter air into the region, countering the elevated temperatures and drying out associated with the end of the monsoon.

Water Supply: In Arizona, total reservoir storage dropped by 69,000 acre-feet (AF) in September, putting total reservoir capacity at 46 percent (compared to 48 percent last year). In New Mexico, there was a small increase of 28,000 AF in total reservoir storage, putting the total reservoir capacity for September at 22 percent--a 1 percent increase from last year. Regional water storage remains a key concern given the accumulated water deficit associated with a multi-year drought.

Drought: This year's monsoon totals, in conjunction with tropical storm moisture, reduced the severity of short-term drought in Arizona and New Mexico. Longer-term drought persists, especially as it relates to multi-year water supply deficits. The potential for above-average precipitation associated with a likely El Niño event offers some hope for relief.

Monsoon: Seasonal monsoon precipitation totals in the past 30 days were above average in most of Arizona and New Mexico, with notable exceptions in the Four Corners region, northeastern New Mexico, and pockets of southern Arizona. These totals were affected by intense precipitation events linked to the repeated incursion of tropical storm systems, and some locations saw most of their seasonal precipitation fall in a single storm event, sometimes even in a single day.

ENSO: The latest ENSO projections forecast more than a 65 percent probability that El Niño conditions will materialize this winter, with relative certainty that this will be a weak event if and when it forms.

Tropical Storms: As predicted, the frequency and intensity of tropical storm activity in the Eastern Pacific was above average in 2014. Hurricane Amanda jumpstarted the season in May, and most early-season storms veered into the Pacific and toward Hawaii. As the season progressed, tropical storms followed the expected pattern of recurving back toward the Pacific Coast, and a number of named tropical storms drove wind and precipitation into southern Arizona and New Mexico.

Precipitation & Temperature Forecasts: Short-term outlooks indicate an increased probability of above-average temperatures and below-average precipitation for the next few weeks. Longer-term and seasonal outlooks still forecast an increased probability of wetter and colder-than-average conditions linked to the El Niño event forecast to peak by mid-winter.

Tweet Oct SW Climate Snapshot

CLICK TO TWEET

New (Oct) SW Climate Outlook - Climate Summary, ENSO Forecast, Monsoon Recap, Water Supply, and CLIMAS News http://bit.ly/1F6wj4W

Online Resources

Figure 1a-3a
Climate Science Applications Program - University of Arizona Cooperative Extension
http://cals.arizona.edu/climate/misc/monsoon/az_monsoon.html

Figure 1b-3b

CSAP - University of Arizona Cooperative Extension
http://cals.arizona.edu/climate/misc/monsoon/nm_monsoon.html

For more maps and other climate information, visit the Climate Science Applications Program (CSAP):

http://cals.arizona.edu/climate/

Monsoon Recap (June 15 – Sep 30)

Looking back on the 2014 monsoon, a simple characterization of the season as 'normal' or 'average' (or above or below these thresholds) is difficult, given the spatial and temporal variability of monsoon storms. The cumulative seasonal totals provide one way of characterizing the monsoon, and by those metrics, the Southwest saw an average to above-average summer rainy season, with much of Arizona and New Mexico receiving well above-average rainfall.

Most of Arizona received well above-average monsoon rainfall—200 to 400 percent of average—and many areas in the state registered 150 percent of their seasonal total or higher. The exceptions were across most of the Four Corners region and in portions of Pima, Pinal, and Graham counties (Fig. 1a). Precipitation intensity (Fig. 2a) identifies areas that received a significant portion of their monsoon precipitation in a few extreme events, with the Phoenix metropolitan area and portions of western Arizona being prime examples of more intense precipitation. Figure 3a (the percentage of days observing 0.01 inch of rain or more) further illustrates this pattern by highlighting areas that received more frequent and steady rain (e.g., much of the southeastern portion of the state) compared to areas with much less frequent rain (e.g., Phoenix, western Arizona, and the Four Corners region).

New Mexico saw a similarly strong, if not stronger, monsoon, with most areas of the state receiving more than 200 percent of their seasonal average and large swaths of southern New Mexico recording between 300 and 400 percent of their seasonal average (Fig. 1b). The exceptions were the Four Corners region and the northeastern corner of the state. New Mexico monsoon precipitation intensity (Fig. 2b) shows a relatively even pattern, with more widespread coverage and less variability compared to Arizona. The graphic depicting percent of days with rain in New Mexico (Fig. 3b) shows larger areas of more frequent but less intense precipitation, with a large percentage of the state experiencing measurable precipitation on at least a third of days during the monsoon.

(cont. on next page)

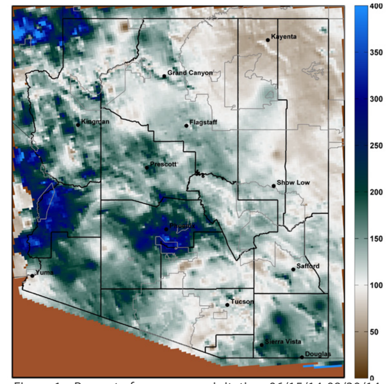


Figure 1a: Percent of average precipitation: 06/15/14-09/30/14

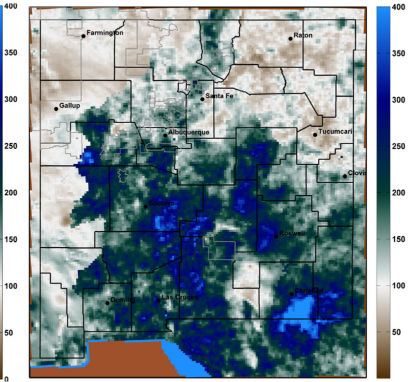


Figure 2a: Percent of average precipitation 06/15/14-09/30/14

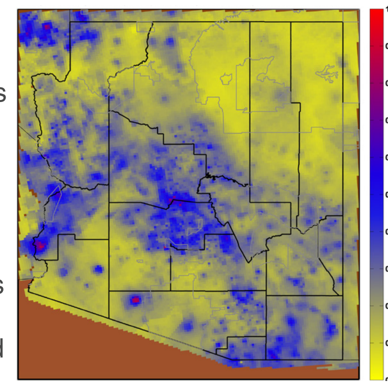


Figure 1b: Daily intensity index 06/15/14-09/30/14

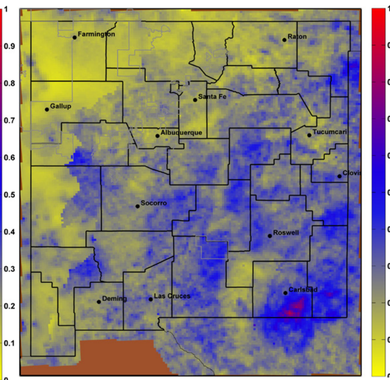


Figure 2b: Daily intensity index 06/15/14-09/30/14

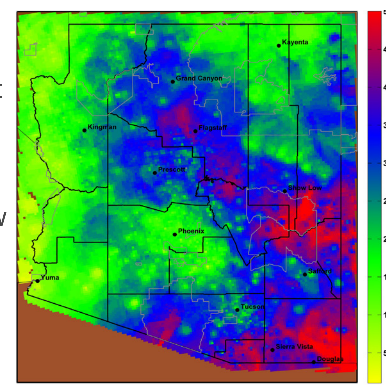


Figure 1c: Percent of days with rain 06/15/14-09/30/14

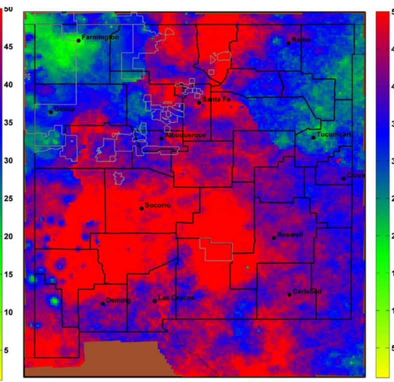


Figure 2c: Percent of days with rain 06/15/14-09/30/14

Online Resources

Figure 4
National Weather Service
http://www.wrh.noaa.gov/twc/monsoon/rainfall.php

Figure 5-7

CSAP - University of Arizona Cooperative Extension
http://cals.arizona.edu/climate/misc/monsoon/monsoon_summaries.html

For more maps and other climate information, visit the Climate Science Applications Program (CSAP):

http://cals.arizona.edu/climate/

The variability and intensity of these storms is only hinted at in seasonal totals however, and the monsoon is notoriously spatially variable and inconsistent. It is not uncommon for 1–2 inches of rain to fall in midtown Tucson and be dry in the foothills, or vice versa, for example, and many metrics are based on the placement of a limited number of rain gauges. This is an important point because during numerous precipitation events this season, a single storm dropped a season's worth of rain in a day (and in a few cases, in a few hours), but the coverage was not always consistent or uniform.

These storms also drive above-average seasonal totals, which has a limited effect on mitigating drought compared to steady and consistent rains, increase disaster potential due to intense precipitation (e.g., Tropical Storm Norbert in Phoenix and Tucson), and underscore the complexity of planning a large urban area for a possible storm event (e.g., Tropical Storm Odile in Tucson). Citizen science enterprises such as rainlog.org provide a more detailed and nuanced picture of monsoon variability through crowdsourcing of precipitation measurement, but the standard measure is still a comparison of the seasonal totals measured at stations in the Southwest (Fig. 4). The intensity and percent of days with rain (Figs. 2-3, above), help illustrate different patterns of steady vs. intense precipitation, but cumulative monsoon precipitation plots also help clarify variation in precipitation intensity.

Three plots (Figs. 5-7) help explain these different types and intensities of rain events. In September, Phoenix (Fig. 5) received almost all of its monsoon precipitation in two single days, and a majority of the rain fell in a single day when Norbert pushed in from the Gulf of California on Sept. 7. The precipitation plot for the Coronado National Monument (Fig. 6) shows a much more even precipitation pattern, with numerous smaller storms spread out over the season; the largest single-day rain event was associated with the incursion of moisture from Odile). The precipitation plot for Tucson (Fig. 7) falls in the middle, with more frequent and smaller storms compared to Phoenix, but longer dry spells and gaps in monsoon precipitation compared to Coronado NM HQ. Norbert is also clearly identifiable in this plot.

This comparison helps illustrate that while extreme precipitation events may provide short-term drought relief and precipitation totals may indicate water deficit improvements, long-term drought conditions will persist and are best mitigated by similarly long-term patterns of above-average precipitation, especially as we look forward to the winter precipitation season.

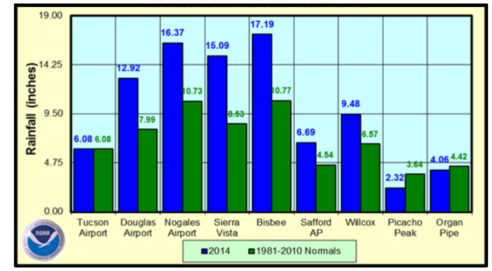


Figure 4: NWS Preliminary 2014 Monsoon rainfall totals vs. normal

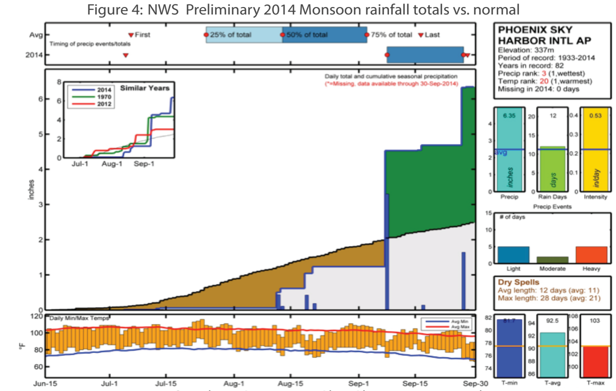


Figure 5: Cumulative Precipitation Plot - Phoenix International Airport

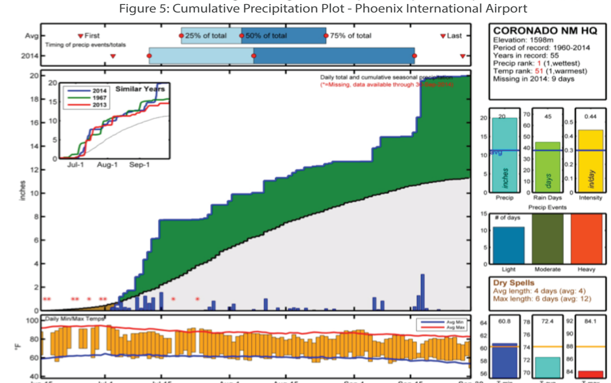


Figure 6: Cumulative Precipitation Plot - Coronado National Monument HQ

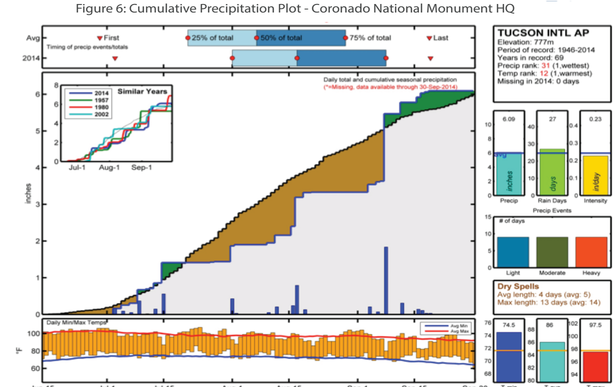


Figure 7: Cumulative Precipitation Plot - Tucson International Airport

Online Resources

Figure 1.
International Research Institute for Climate & Society
http://iri.columbia.edu/our-expertise/climate/forecasts/enso/

2014-15 El Niño Tracker

An El Niño Watch, issued by the NOAA Climate Prediction Center (CPC), continues for the seventh consecutive month as signs of an emerging El Niño are just on the horizon, but not quite here yet. Another slug of warm water (also known as a Kelvin wave), has been making its way across the Pacific Ocean from west to east just below the surface and is poised to emerge and help warm sea surface temperatures in the eastern Pacific over the next month or so. Westerly wind bursts, which help move this warmer-than-average water to the east, have occurred in the western and central Pacific but have been temporary and haven't helped sustain a steady progression towards El Niño conditions, which typically peak during mid-winter.

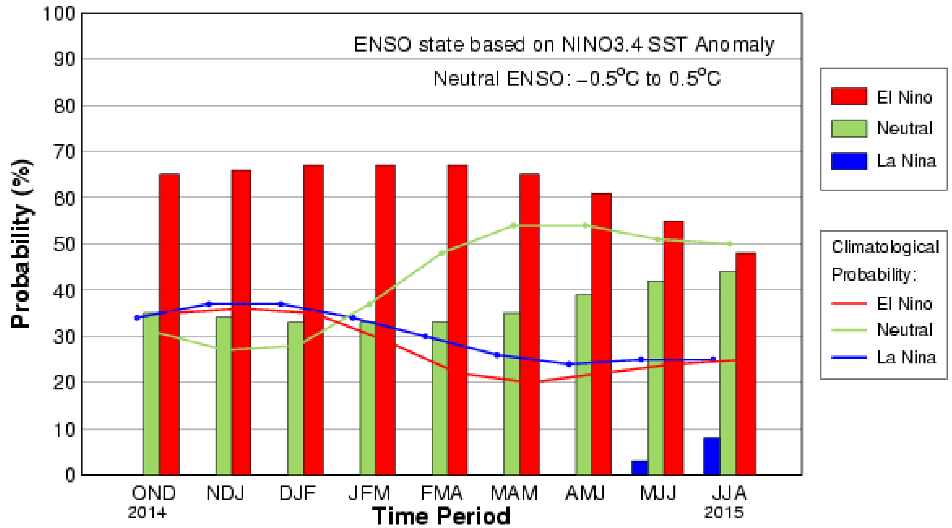


Figure 1: Mid-Oct IRI/CPC Plume-Based Probabilistic ENSO Forecast

Forecast models are betting the current Kelvin wave and associated warm water in the east Pacific will finally get this fickle event to organize and roll forward as a weak El Niño; only a handful of models suggest a moderate-strength event. The early-October consensus forecast (Fig. 1) issued by the International Research Institute for Climate and Society (IRI) and the CPC still indicates more than a 65 percent chance of El Niño conditions developing during the November-December-January period and most likely persisting through early next spring. The impacts associated with weak El Niño events are much less certain than with stronger events, with similar past events bringing both dry and wet conditions to the Southwest U.S. during the winter. Seasonal precipitation forecasts still indicate an enhanced chance of above-average precipitation over the upcoming winter, but confidence in this forecast has wavered slightly because of the expected weak nature of the emerging El Niño.

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

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).

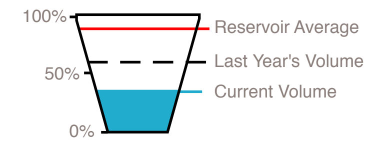
The table details more exactly the current capacity (listed as a percent of maximum storage). Current and maximum storage are given in thousands of acre-feet for each reservoir. One acre-foot is the volume of water sufficient to cover an acre of land to a depth of 1 foot (approximately 325,851 gallons). On average, 1 acre-foot of water is enough to meet the demands of 4 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.

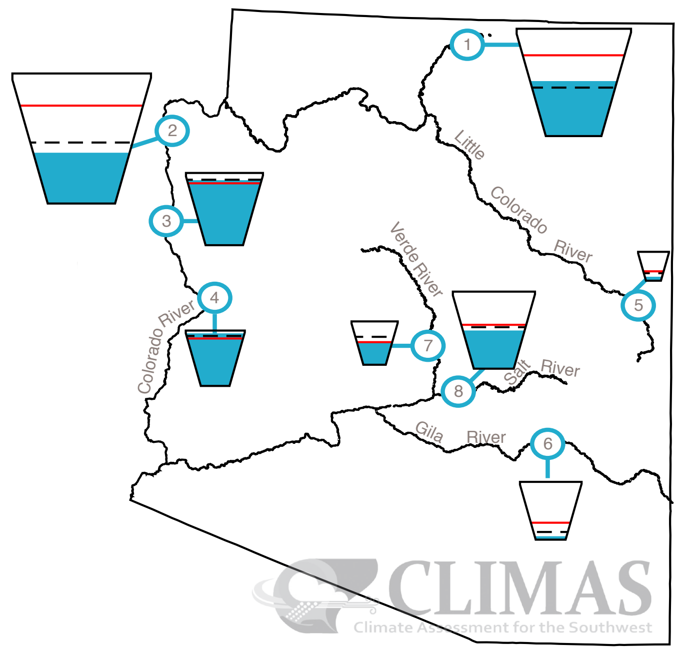
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS).

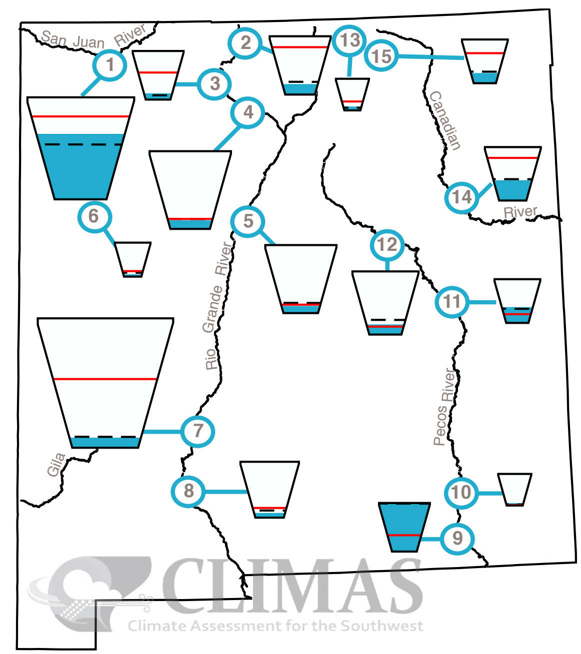
Reservoir Volumes

DATA THROUGH SEPTEMBER 30, 2014

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%	12,286.0	24,322.0	-28.0
2. Lake Mead	39%	10,121.0	26,159.0	-19.0
3. Lake Mohave	91%	1,645.2	1,810.0	-65.3
4. Lake Havasu	94%	583.2	619.0	1.3
5. Lyman	13%	4.0	30.0	-0.7
6. San Carlos	6%	53.1	875.0	32.6
7. Verde River System	52%	148.4	287.4	5.3
8. Salt River System	49%	984.4	2,025.8	5.2

*KAF: thousands of acre-feet

Reservoir	Capacity	Current Storage*	Max Storage*	One-Month Change in Storage*
1. Navajo	64%	1080.6	1,696.0	- 7.8
2. Heron	18%	70.6	400.0	-0.2
3. El Vado	12%	23.3	190.3	-28.3
4. Abiquiu	11%	129.9	1,192.8	0.3
5. Cochiti	10%	47.2	491.0	-0.5
6. Bluewater	7%	2.7	38.5	-0.1
7. Elephant Butte	8%	172.1	2,195.0	18.1
8. Caballo	9%	31.1	332.0	8.8
9. Lake Avalon	110%	4.4	4.0	0.1
10. Brantley	8%	76.7	1,008.2	39.2
11. Sumner	36%	36.7	102.0	0.2
12. Santa Rosa	16%	71.9	438.3	0.2
13. Costilla	13%	2.0	16.0	-1.1
14. Conchas	38%	96.8	254.2	-2.2
15. Eagle Nest	23%	18.4	79.0	-1.1

* in KAF = thousands of acre-feet

Southwestern Oscillations

A longer version of this article can be found on the CLIMAS blog

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

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

Online Resources

Figure 1.
NCEP/NCAR Reanalysis
http://www.esrl.noaa.gov/psd/data/reanalysis/reanalysis.shtml

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

Notes from an Applied Climatologist: Monsoon End Q&A

How Do We Know When the Monsoon is Over?

Across the Southwest United States, the start of the monsoon is pretty easy to recognize once you have experienced it firsthand. In late June or early July, it's hot and dry one week, and hot and sticky the next, but hopefully raining. The start is relatively clear cut, but calling an end to the monsoon is a bit trickier because there isn't a rapid and clean transition back to non-monsoon weather conditions in the fall, and breaks in the monsoon can complicate this transition.

The monsoon circulation pattern and resultant precipitation across the Southwest is largely governed by the position and strength of the subtropical high, also known as the monsoon ridge (Fig. 1). This high pressure system builds north through Mexico into the Southwest from June into July, causing the winds to shift from a dry westerly flow in mid-levels of the atmosphere to a moister, subtropical easterly flow. This shift in wind direction is a key to defining the beginning, as well as the end, of the monsoon. The monsoon ridge typically starts to weaken and retreat through September but can build and subside throughout the month. September is also often when tropical storm moisture can interact with early-season autumn storms moving in from the north Pacific, sparking widespread thunderstorm activity. These transition events are another indication that the monsoon is almost over and that fall weather is on the doorstep (Fig. 2).

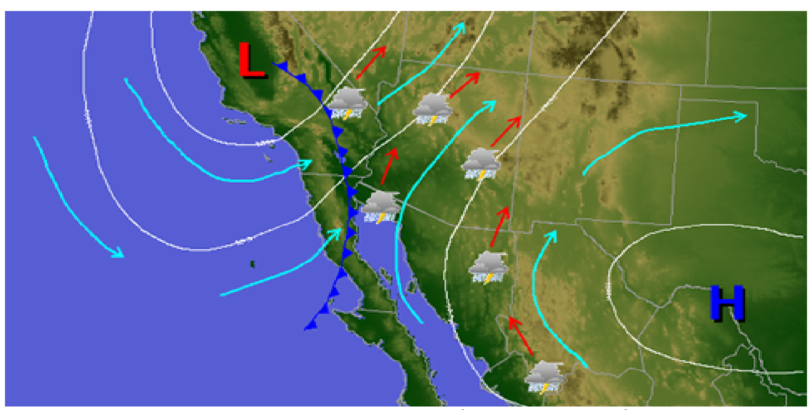


Figure 2: Aug/Sept Transitional Monsoon Period

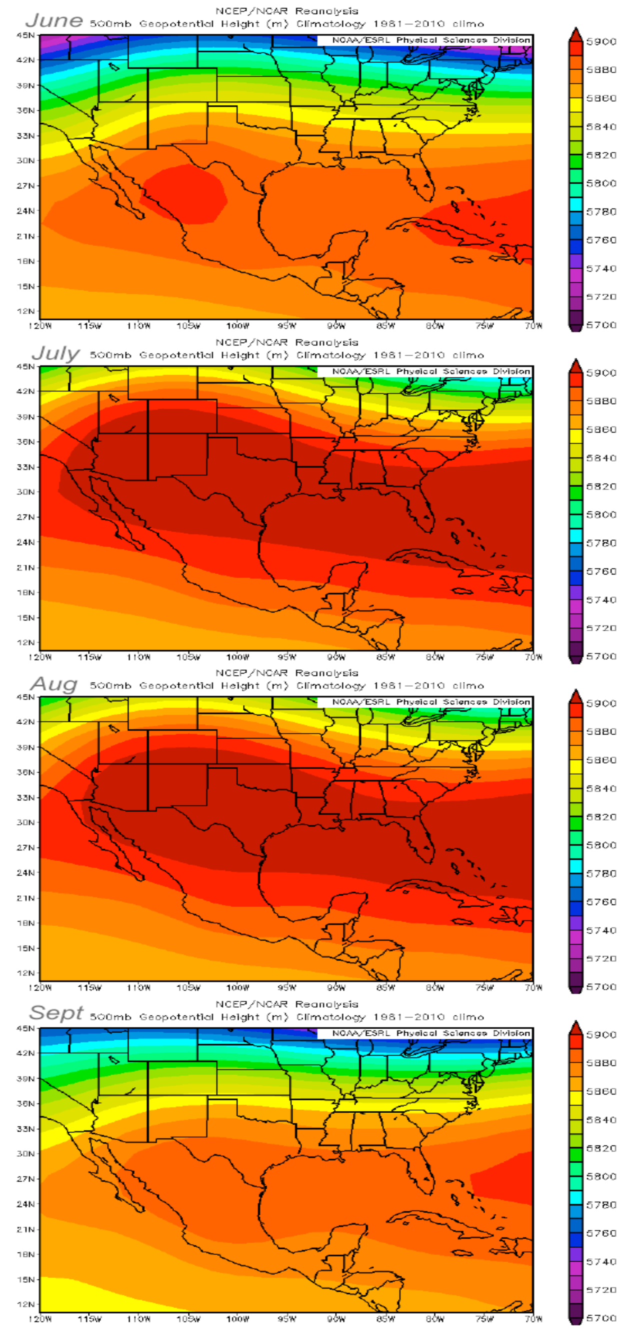


Figure 1: Seasonal Progression of Monsoon Ridge

Southwestern Oscillations

Be sure to visit our blog, Southwestern Oscillations

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

CLIMAS YouTube Channel

Visit our new YouTube channel for mini-videos of content/discussion pulled from the podcast

https://www.youtube.com/user/UACLIMAS/

CLIMAS Podcasts

Visit our website or iTunes to subscribe to our podcast feed

www.climas.arizona.edu/media/podcasts

https://itunes.apple.com/us/itunes-u/climate-in-the-southwest/id413143045

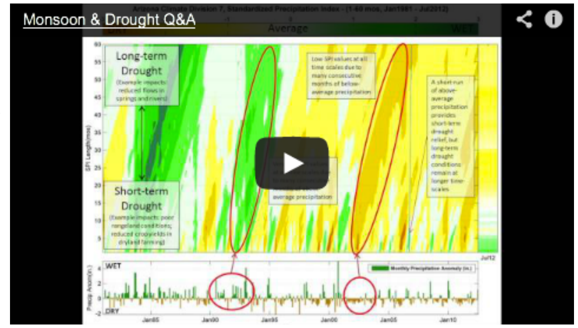
Notes from the Podcast - New Mini-Podcast Videos

Regular podcast listeners will know that we cover a wide range of Southwest climate topics in a conversational manner. To make these discussions even more accessible and useful, we are pulling small segments from the podcasts and adding maps, images, and video to supplement the content. These offer an opportunity to quickly digest key points from the podcast and also serve as stand-alone teaching/illustration tools that are suitable for a wide range of audiences. You can find the videos and subscribe to the YouTube channel at https://www.youtube.com/user/UACLIMAS/.

We already have posted several mini-video podcasts:

Monsoon and Drought Q&A

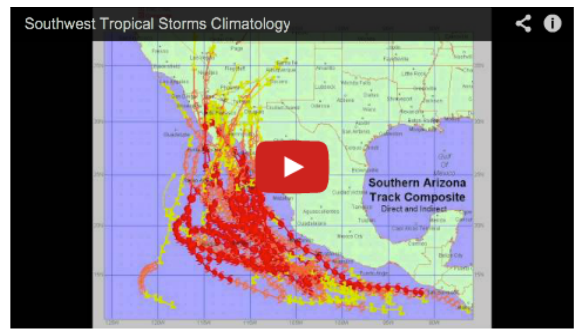
https://www.youtube.com/watch?v=Dk001_Yr-7k



Southwest Tropical Storm Climatology

https://www.youtube.com/watch?v=IPRQxKI_jrw

and



El Niño Forecast Models Q&A

https://www.youtube.com/watch?v=Dk001_Yr-7k