

# **Building a drought monitoring toolbox for AZ: Experimental Tools and Programs**

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Dept. of Soil, Water, & Environmental Science  
The University of Arizona**



# Presentation Overview

- Tracking drought across Arizona is hard: seasonality, topography, multiple timescales
- Tools need to be flexible and able to capture different scales of variability
- No 'silver bullet' tool or product
- Consulting multiple drought information products good practice...but which ones?



# Climate Science Applications Program

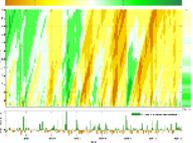
- Deliver relevant climate information to agricultural and resource management communities
- Conduct applied research on SW US climate
- Make climate science useful and useable through extension programming
- Connect CLIMAS and broader UofA climate science community to Extension

Search Contact Site Map

**CSAP**  
Climate Science Applications Program  
UNIVERSITY OF ARIZONA COOPERATIVE EXTENSION

Home About CSAP Projects Workshops Resources Publications Links Contacts

**What's New**

- [Listen to SW Climate Podcasts](#)
- [Help monitor rainfall across Arizona!](#)
- 
- [Monsoon summary plots and maps \[AZ & NM\]](#)
- 
- [Check out a new experimental drought monitoring plot here](#)

**AZ Climate Quick Links**

- [Eye on Drought in Arizona \(AZ ADWR\)](#)
- [Arizona State Climate Office \(ASU\)](#)
- [Western U.S. Weather Info \(NOAA-NWS\)](#)
- [Arizona Climate Maps \(WRCC-DRI\)](#)
- [Arizona Drought Maps \(WWDT\)](#)
- [AZ Climate-Online Learning Module \(UofA\)](#)
- [Arizona Moisture Status \(NOAA\)](#)

**AZ Drought**

- 
- [Track regional drought conditions with DroughtView](#)

**Latest Drought Monitor**

U.S. Drought Monitor  
Arizona

December 1, 2014

Area	Severity
Phoenix	D2
Flagstaff	D1
Tucson	D1
Yuma	D2
Kingman	D2
Prescott	D1
Chandler	D1
Scottsdale	D1
Glendale	D1
Peoria	D1
Chandler	D1
Scottsdale	D1
Glendale	D1
Peoria	D1

**CLIMAS**  
Climate Assessment for the Southwest

**Southwest Climate Outlook**

- [Latest Outlook](#)
- [Archives](#)

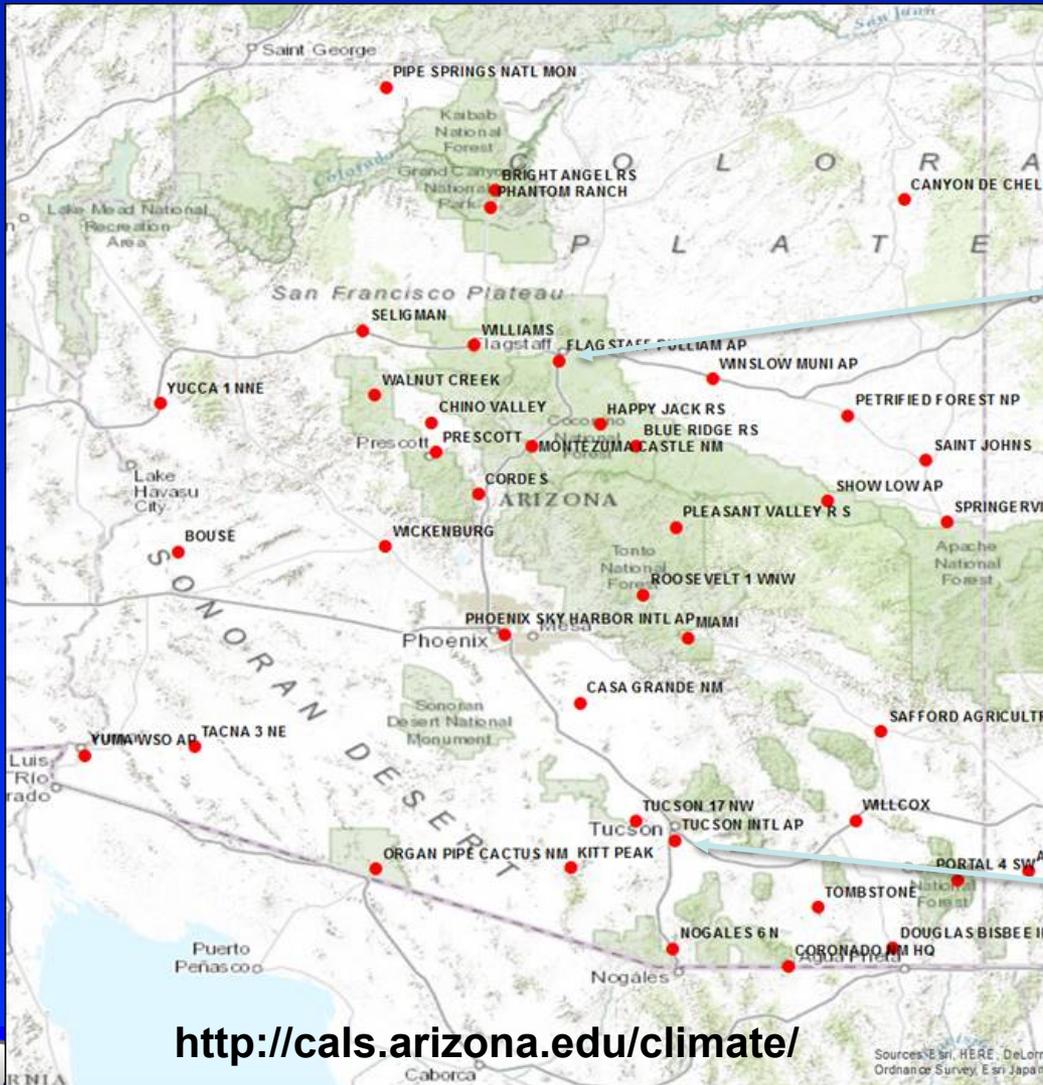
ARIZONA COOPERATIVE EXTENSION DEPT. OF SOIL, WATER & ENVIRONMENTAL SCIENCE COLLEGE OF AGRICULTURE & LIFE SCIENCES THE UNIVERSITY OF ARIZONA

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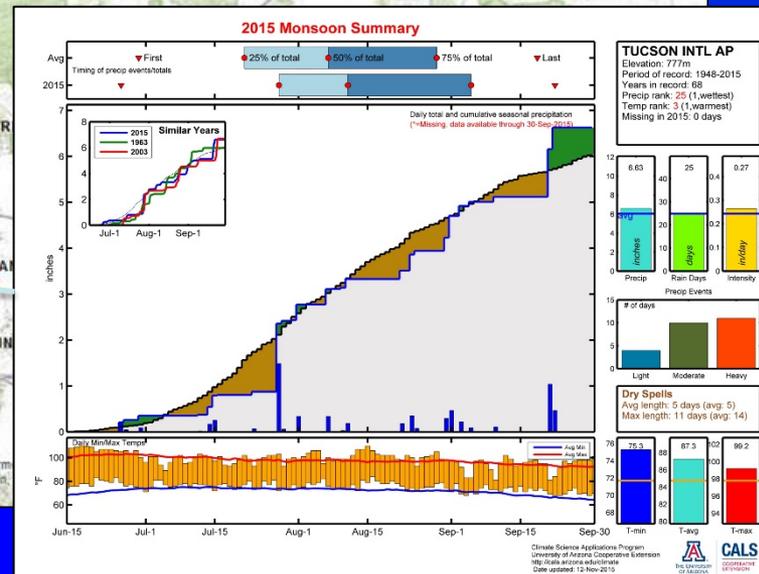
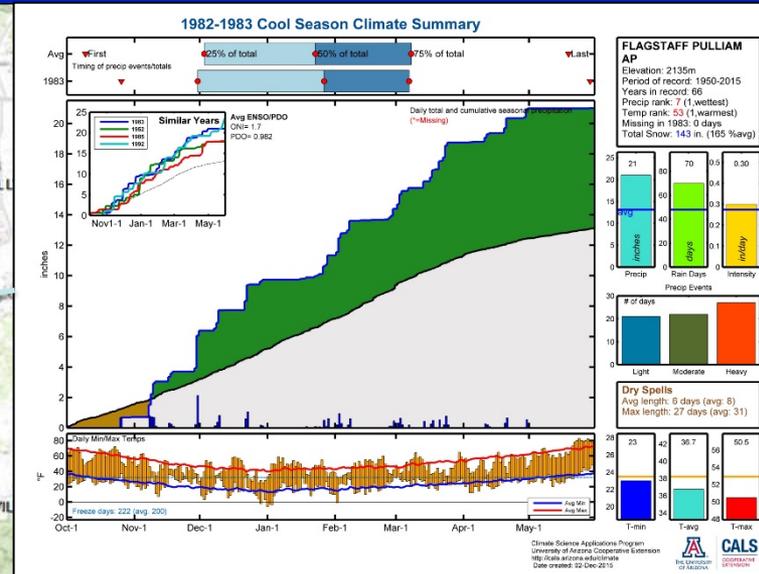
<http://cals.arizona.edu/climate/>



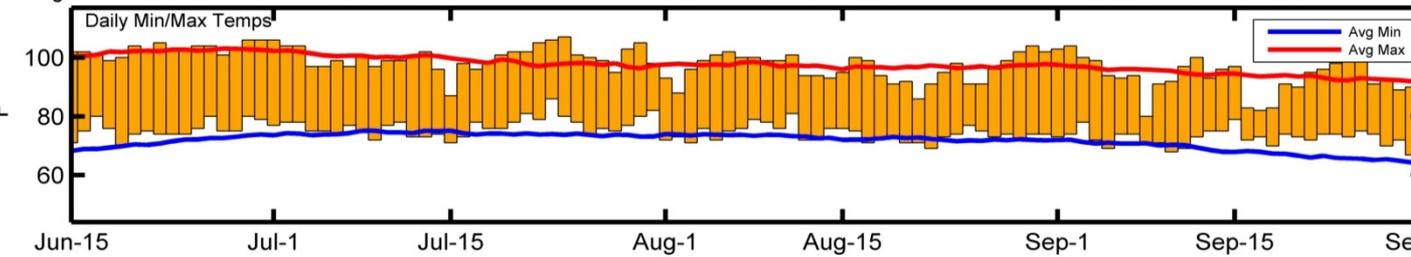
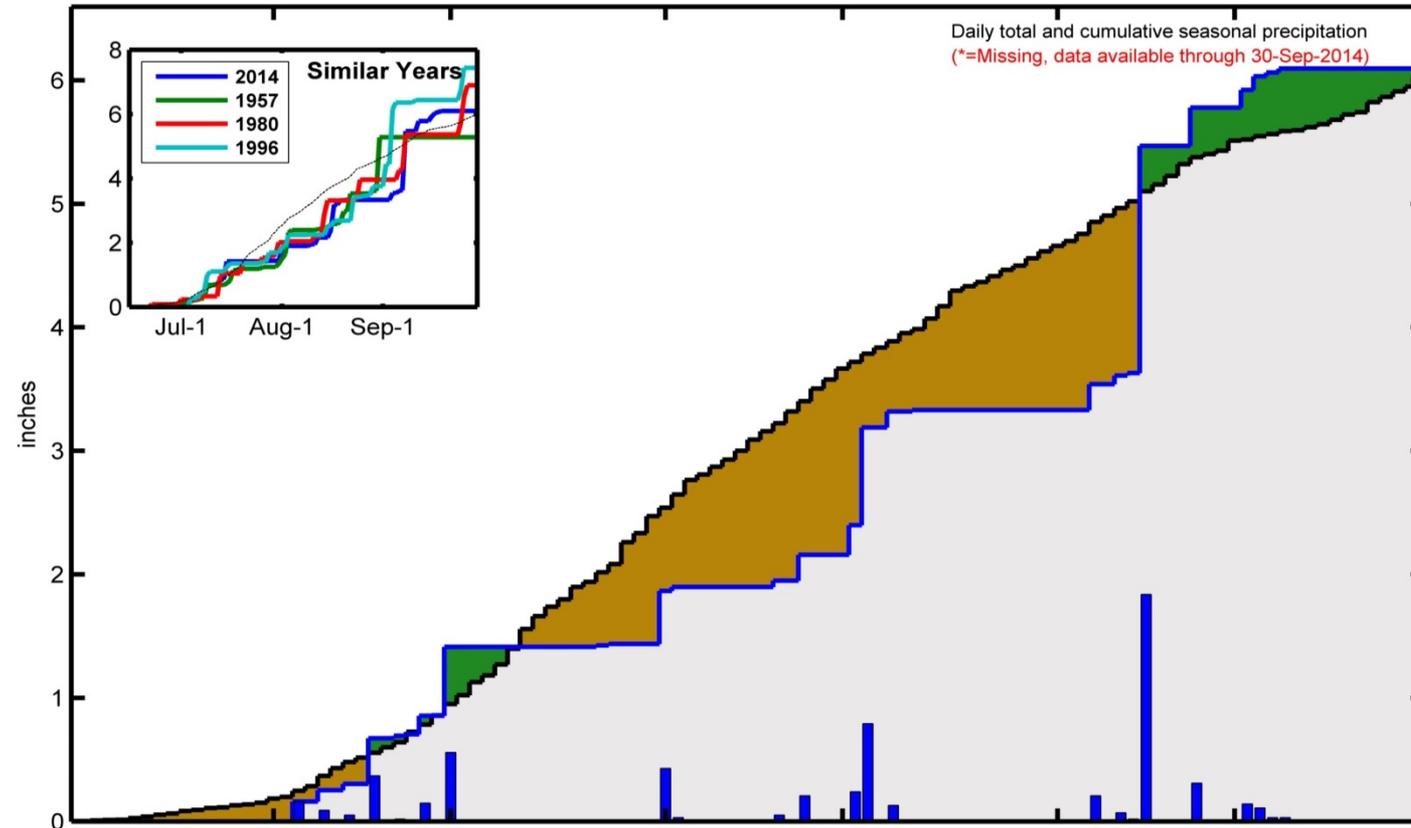
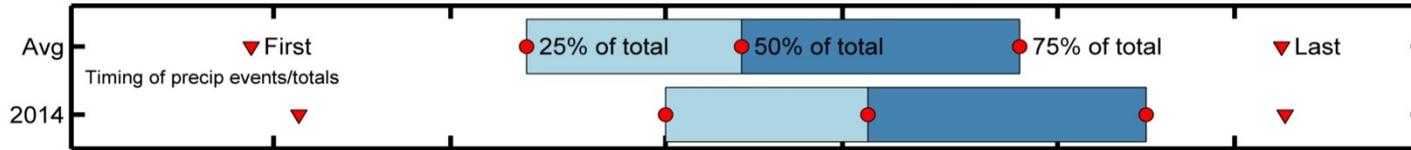
# Station level seasonal climate summaries



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

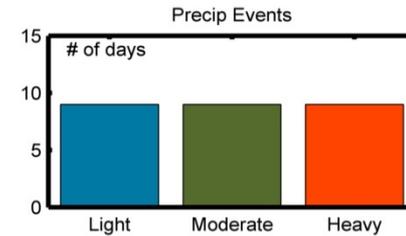
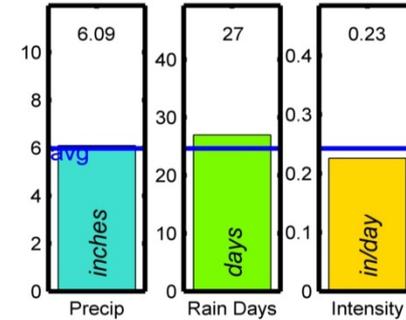


# 2014 Monsoon Summary



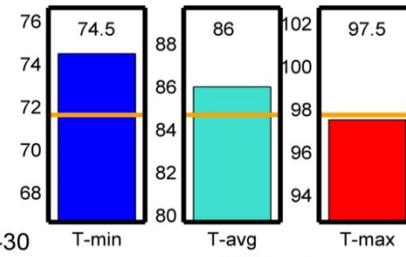
## TUCSON INTL AP

Elevation: 777m  
 Period of record: 1946-2014  
 Years in record: 69  
 Precip rank: 31 (1,wettest)  
 Temp rank: 12 (1,warmest)  
 Missing in 2014: 0 days

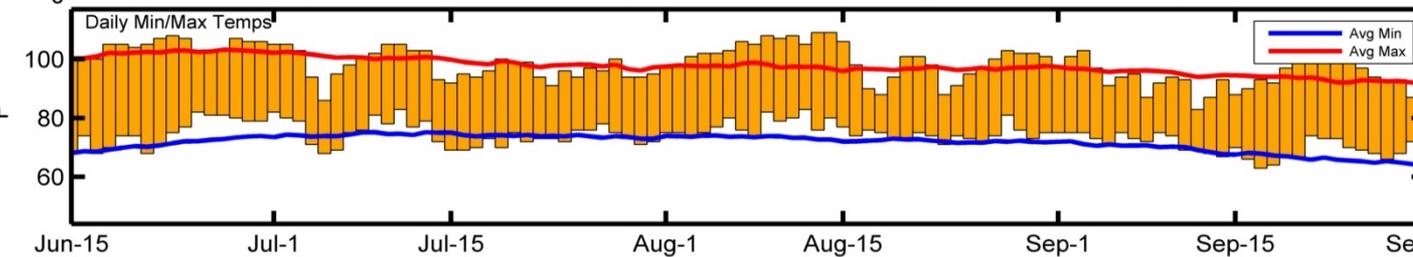
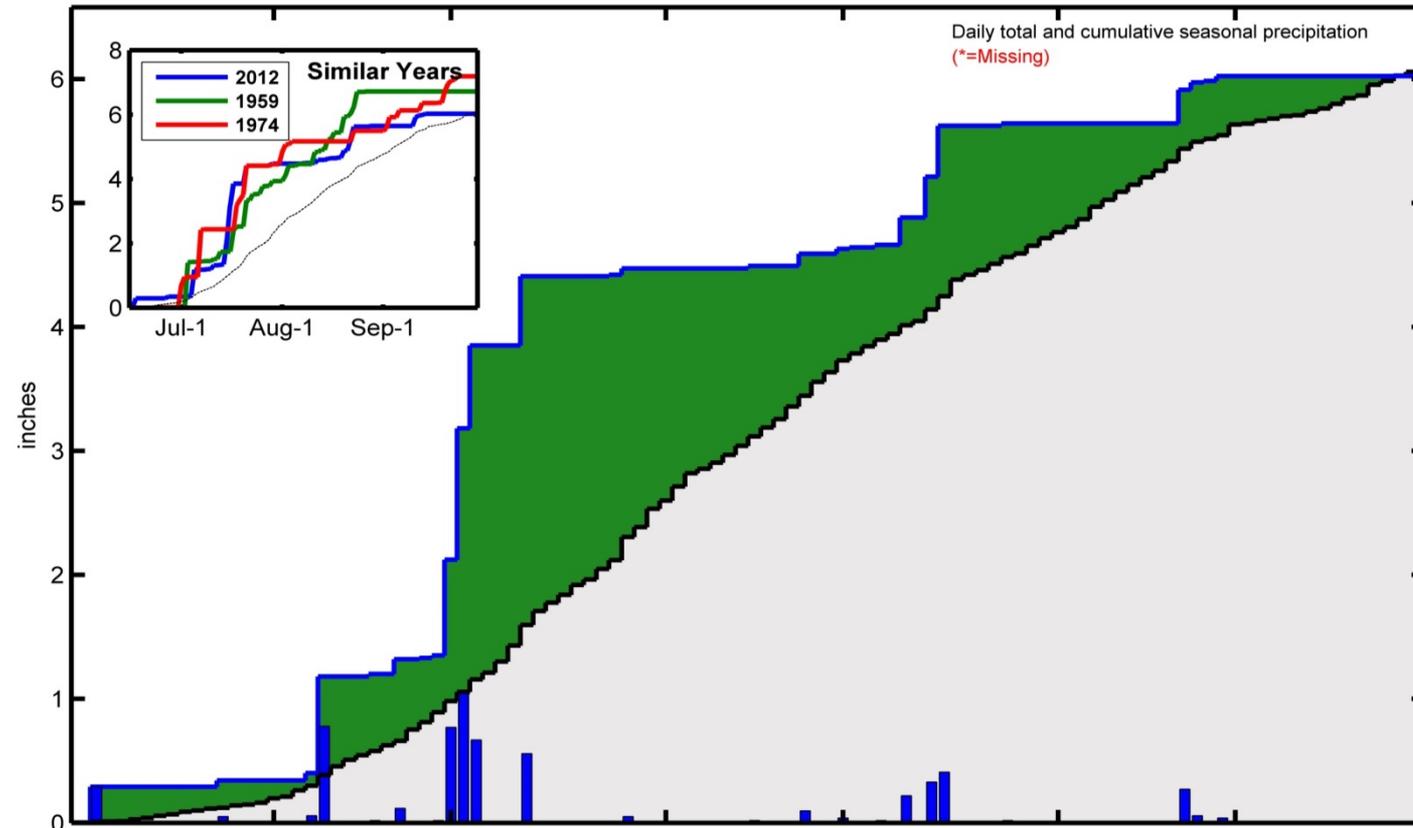
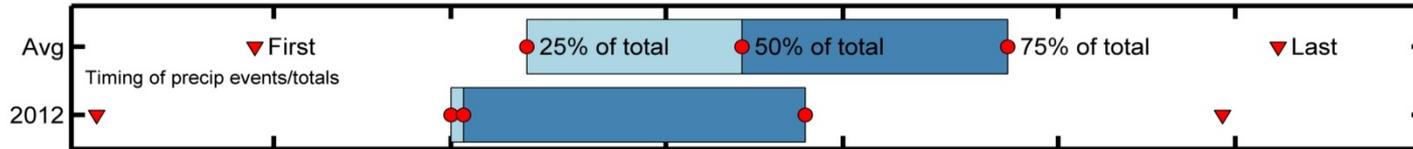


## Dry Spells

Avg length: 4 days (avg: 5)  
 Max length: 13 days (avg: 14)

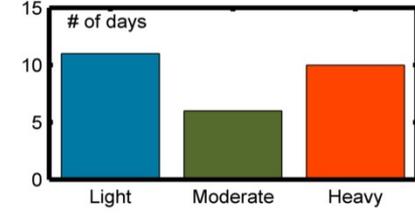
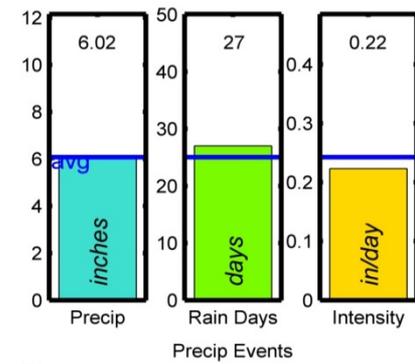


# 2012 Monsoon Summary



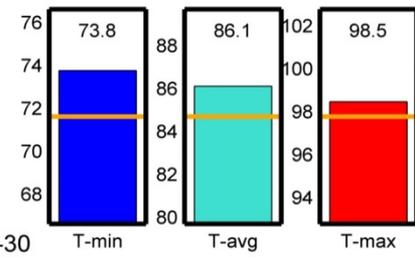
### TUCSON INTL AP

Elevation: 777m  
 Period of record: 1950-2013  
 Years in record: 64  
 Precip rank: 31 (1, wettest)  
 Temp rank: 10 (1, warmest)  
 Missing in 2012: 0 days

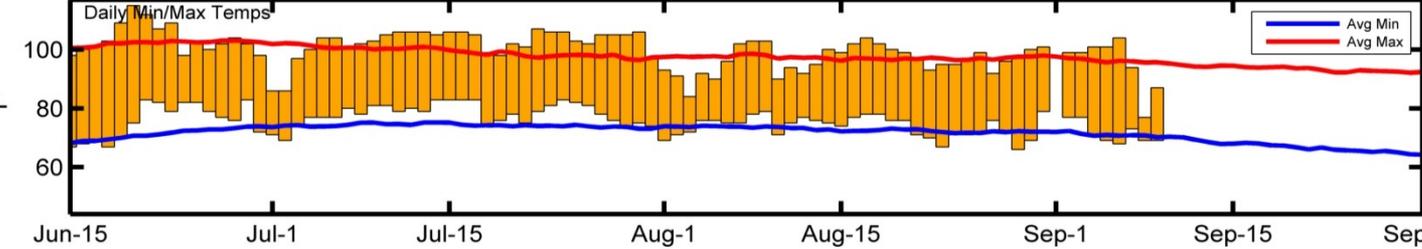
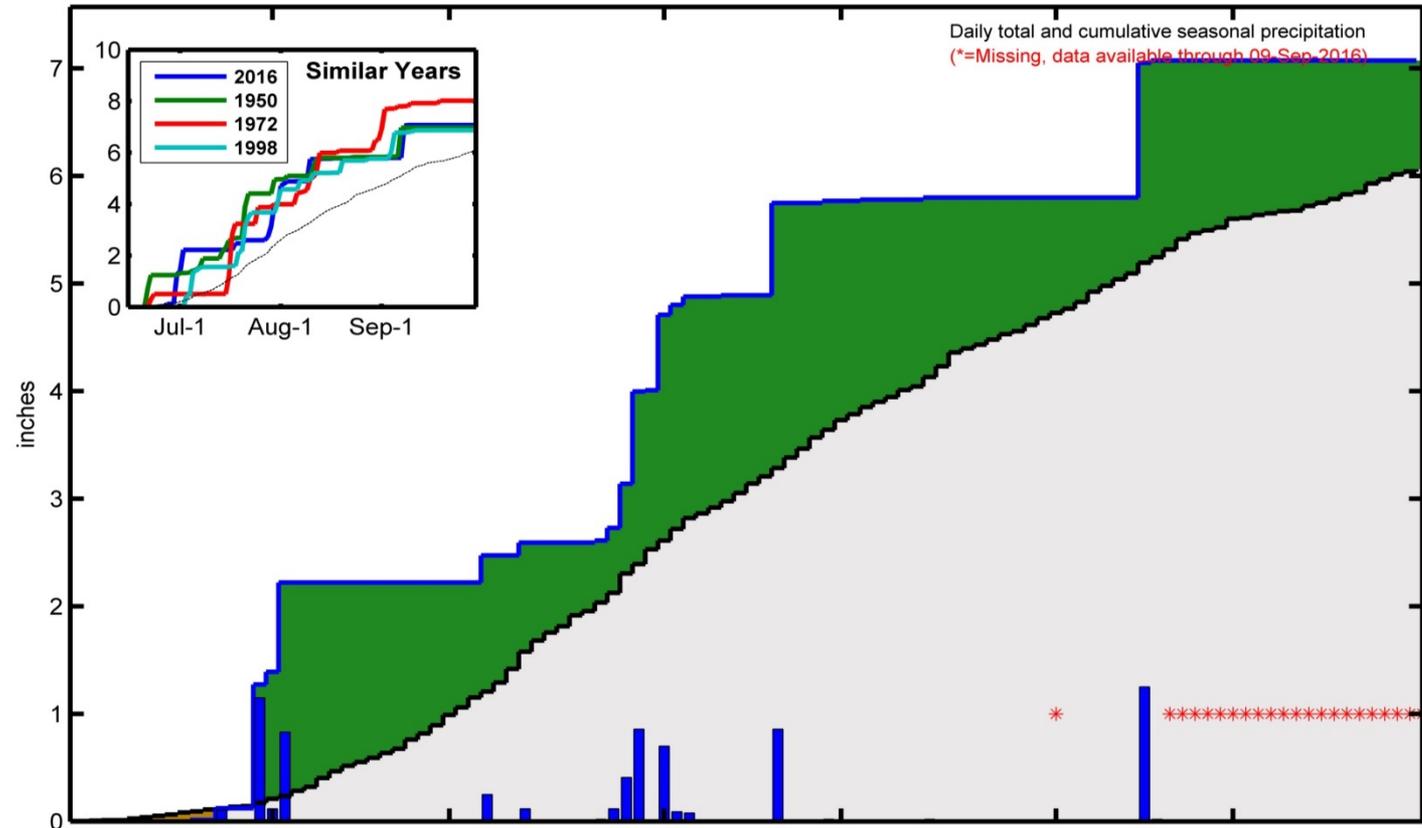
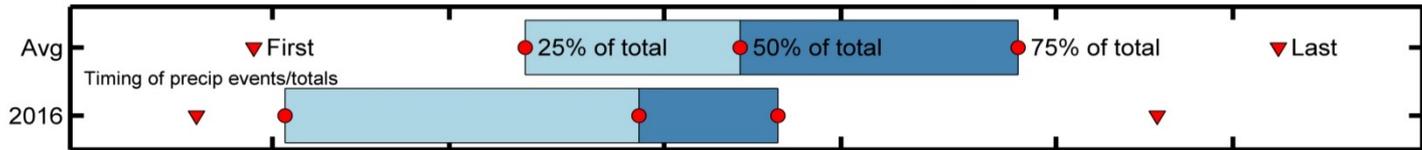


### Dry Spells

Avg length: 4 days (avg: 5)  
 Max length: 13 days (avg: 14)

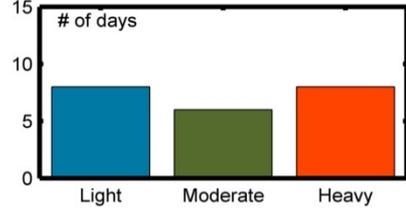
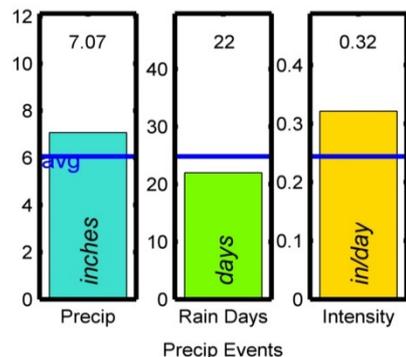


# 2016 Monsoon Summary



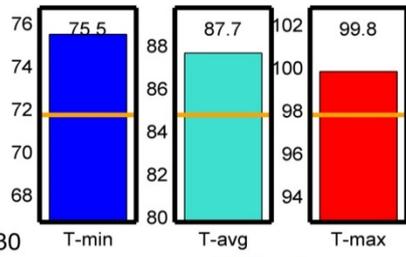
### TUCSON INTL AP

Elevation: 777m  
 Period of record: 1948-2016  
 Years in record: 69  
 Precip rank: 18 (1, wettest)  
 Temp rank: 2 (1, warmest)  
 Missing in 2016: 22 days



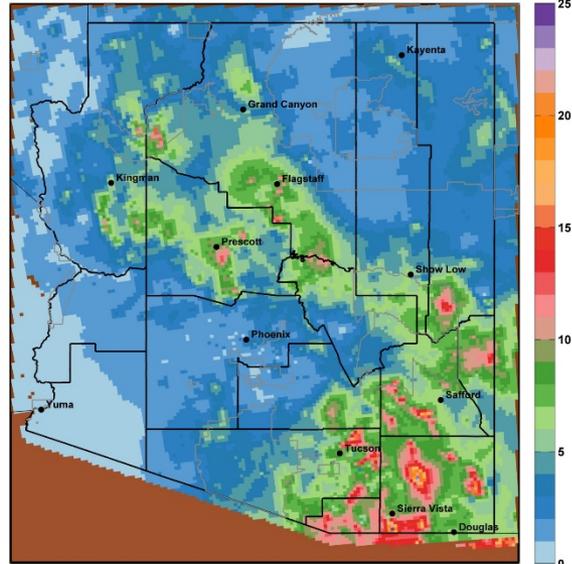
### Dry Spells

Avg length: 5 days (avg: 5)  
 Max length: 16 days (avg: 14)



# Monsoon Season Precip Monitoring Maps

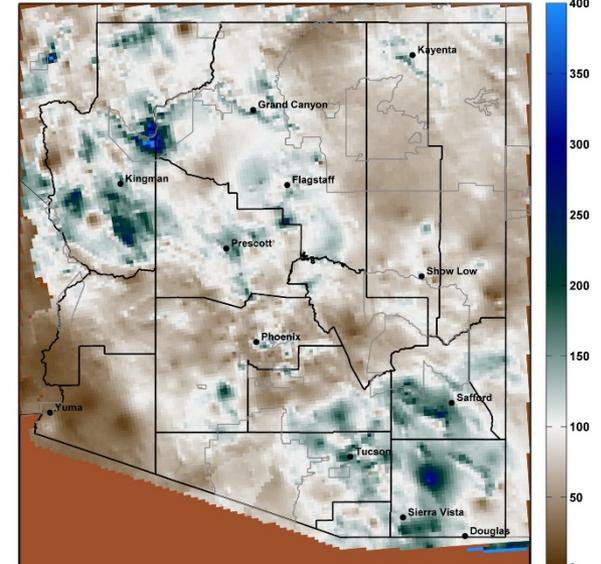
Total Precipitation (in): 06/15/16 to 09/14/16



Map produced using daily total precipitation estimates from the NOAA National Weather Service Advanced Hydrologic Prediction Service (AHPS). Data information available at <http://water.weather.gov/precip/about.php>. Date created: 15-Sep-2016 University of Arizona - <http://cals.arizona.edu/climate/>



Percent of Average Precipitation (%): 06/15/16 to 09/14/16

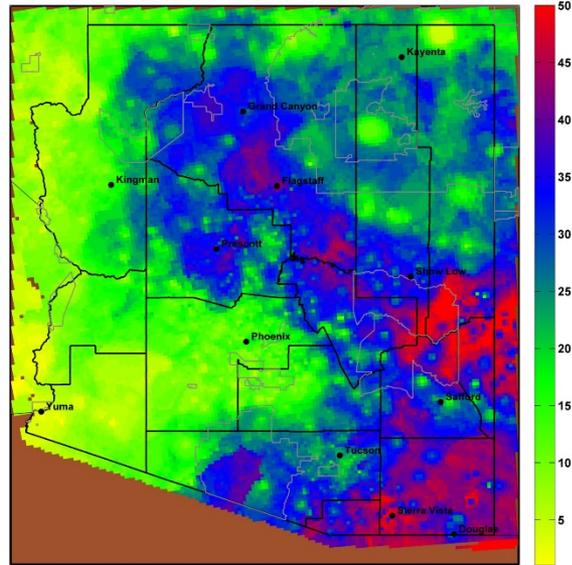


Map produced using daily total precipitation estimates from the NOAA National Weather Service Advanced Hydrologic Prediction Service (AHPS). Data information available at <http://water.weather.gov/precip/about.php>. Date created: 15-Sep-2016 University of Arizona - <http://cals.arizona.edu/climate/>



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

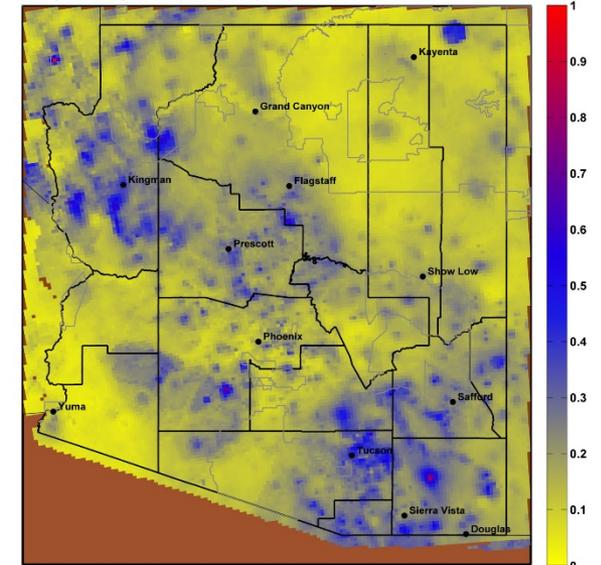
Percent of days with rain (>0.01"): 06/15/16 to 09/14/16



Map produced using daily total precipitation estimates from the NOAA National Weather Service Advanced Hydrologic Prediction Service (AHPS). Data information available at <http://water.weather.gov/precip/about.php>. Date created: 15-Sep-2016 University of Arizona - <http://cals.arizona.edu/climate/>



Daily intensity index (total precip/days with rain): 06/15/16 to 09/14/16



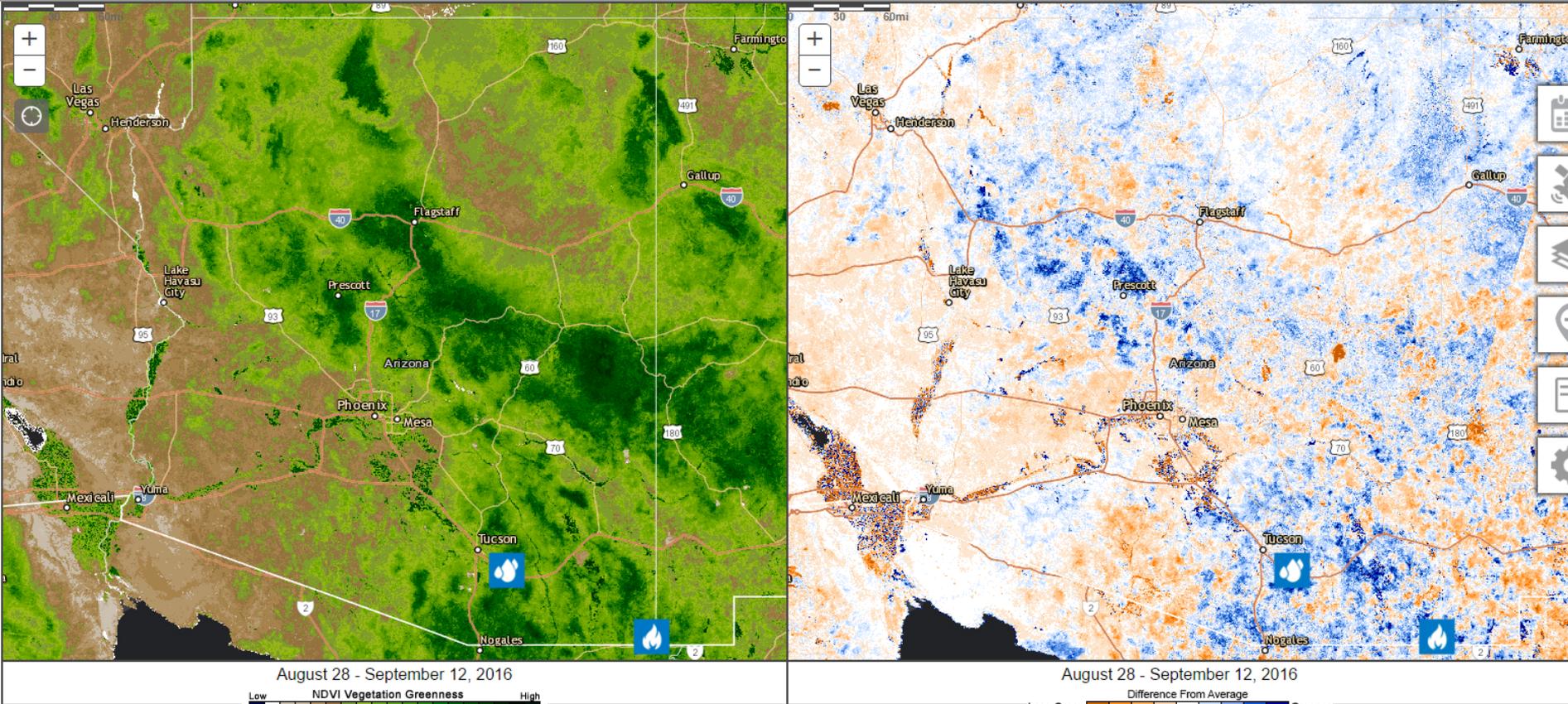
Map produced using daily total precipitation estimates from the NOAA National Weather Service Advanced Hydrologic Prediction Service (AHPS). Data information available at <http://water.weather.gov/precip/about.php>. Date created: 15-Sep-2016 University of Arizona - <http://cals.arizona.edu/climate/>



# DroughtView: Remote sensing (vegetation 'greenness') visualization tool

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DroughtView



<http://droughtview.arizona.edu/>



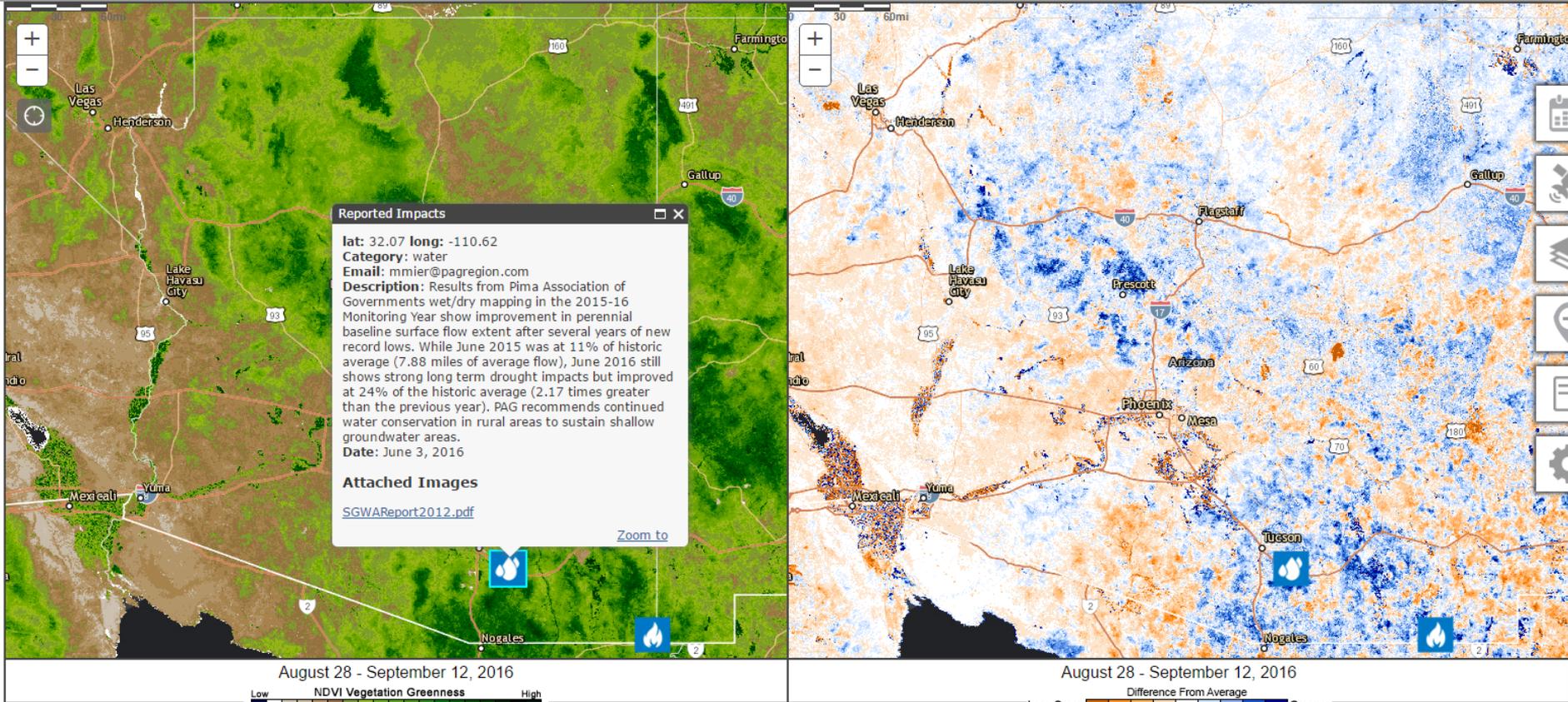
Climate Science Applications Program - University of Arizona Cooperative Extension



# DroughtView: Remote sensing (vegetation 'greenness') visualization tool

THE UNIVERSITY OF ARIZONA

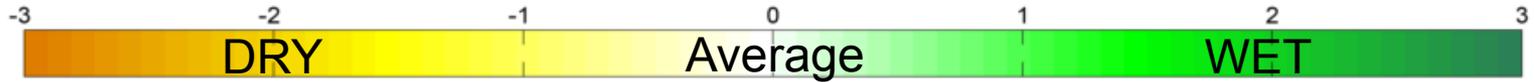
DroughtView



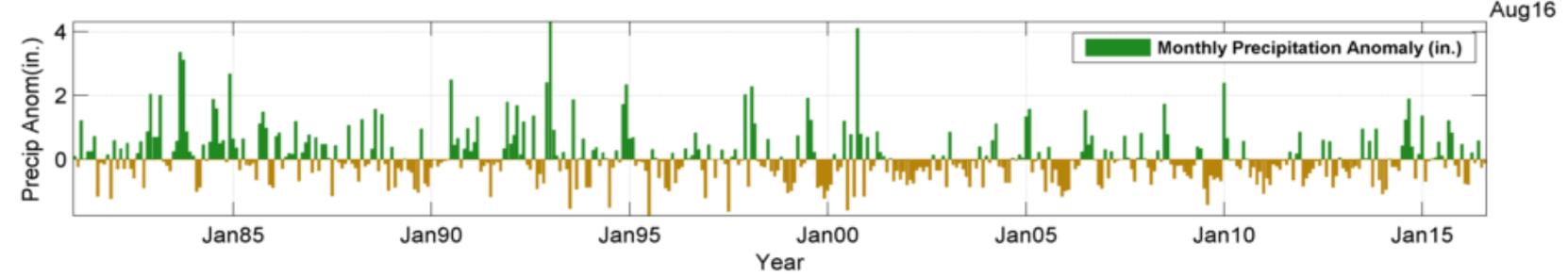
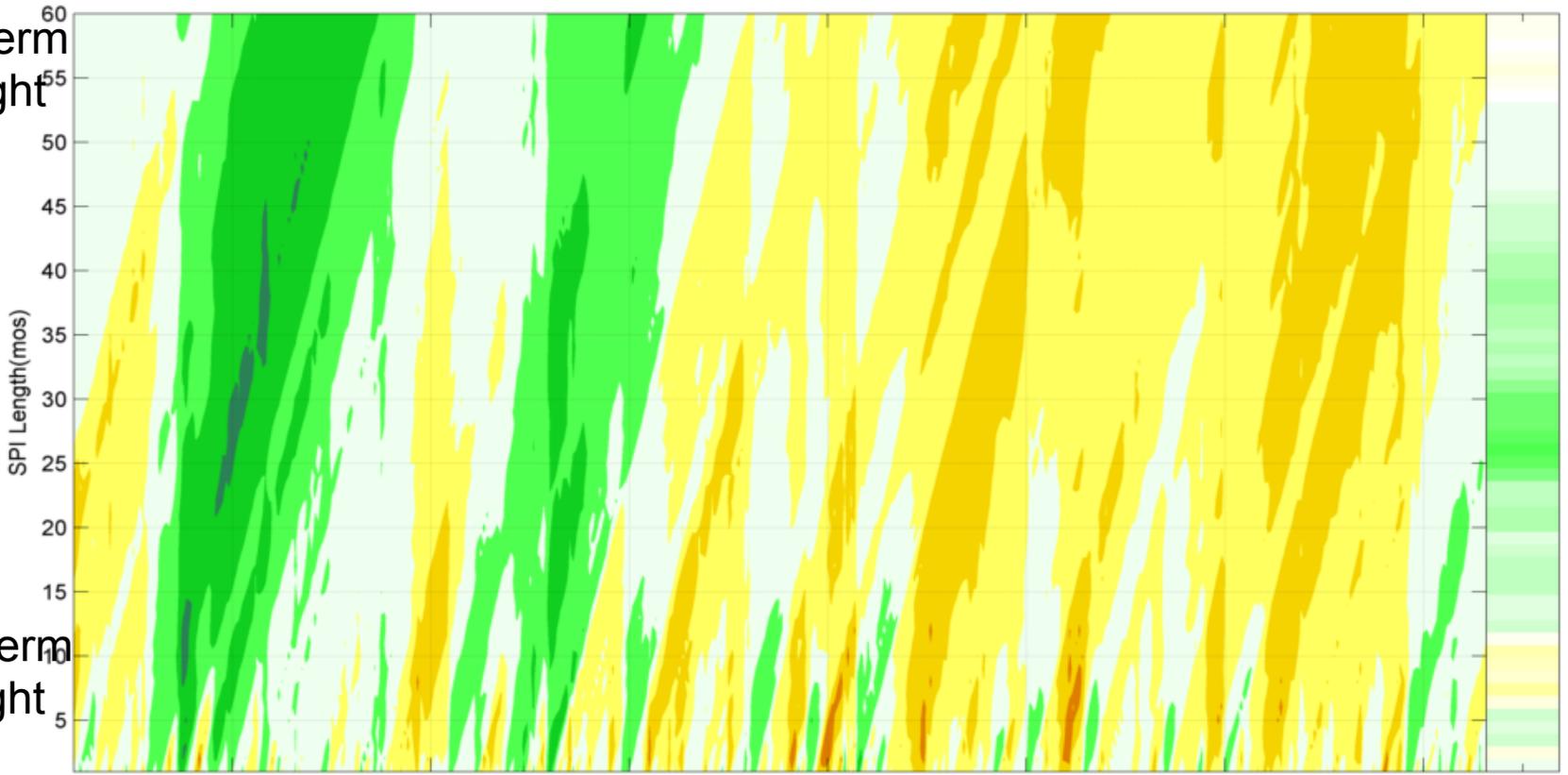
<http://droughtview.arizona.edu/>



# Arizona Climate Division 7, Standardized Precipitation Index - (1-60 mos, Jan1981 - Aug2016)



Long-term Drought ↑  
Short-term Drought



Aug16



# Climate information outreach...

Podcast Series:  
Southwest Climate Podcasts  
Podcast Hosts:  
Michael Crimmins  
Zack Guido  
Producer:  
Ben McMahan  
Emily Huddleston



Sept 2014 Southwest Climate Podcast: Tropical Storm Climatology & El Niño Summary  
Wednesday, October 1, 2014

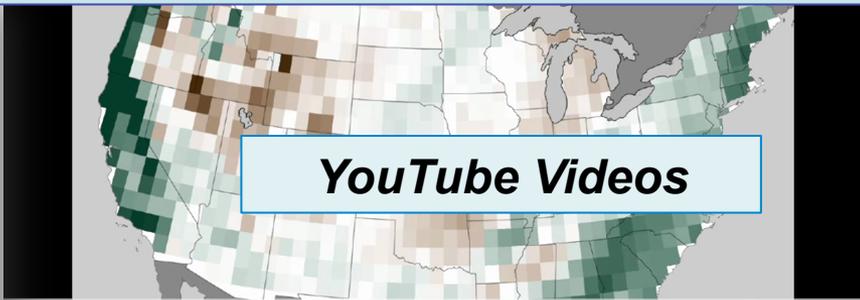
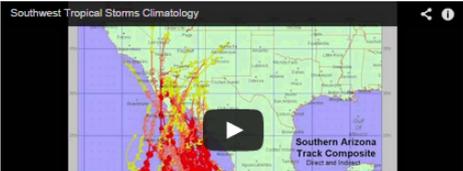


In the Sep  
Norbert ar  
gy, details about  
ted by a listener.

Intro & R  
Tropical S  
Norbert V  
What is a  
El Niño M

We are int  
and addresses monsoon & drought in response to a listener question, and is viewable on youtube. This month's video podcasts will be added to this page as we release them

**Monthly weather and climate podcast, climate outlook**



**YouTube Videos**

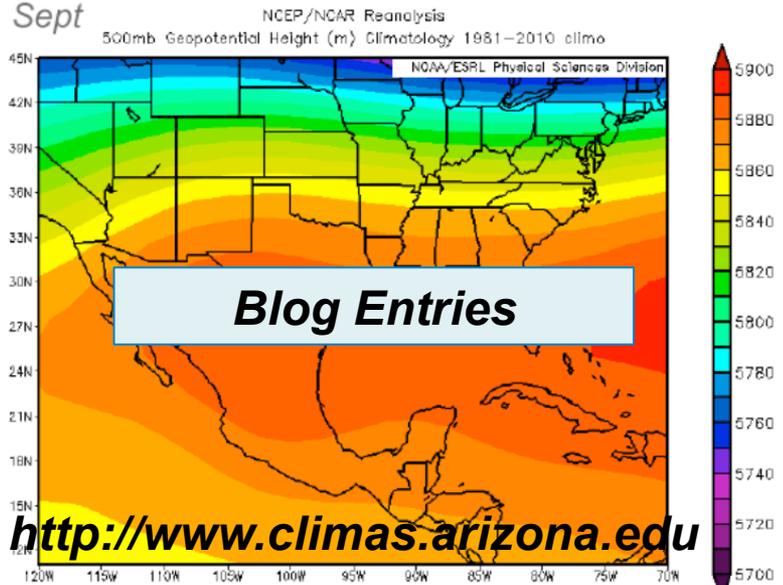
Precipitation Anomalies  
El Niño Events 1950-2010



Mc **Notes from an Applied Climatologist: Monsoon End Q&A**

Monday, September 29, 2014  
Michael Crimmins  
*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. (read more)



**Workshops**

# Where Do Seasonal Climate Predictions Belong in the Drought Management Toolbox?

By Michael A. Crimmins and Mitchel P. McClaran

## On the Ground

- Seasonal climate predictions, based largely on the status of the El Niño-Southern Oscillation, are one such tool but need to be used with prudence, understanding when and where they perform the best.
- Advance planning and preparation for drought includes finding the right place for uncertain climate predictions in management decision making, as well as working to reduce overall exposure to drought risks.

**Keywords:** drought, seasonal climate prediction, forecasts, El Niño-Southern Oscillation.

*Rangelands* 38(4):169–176

doi: 10.1016/j.rala.2016.06.004

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Drought is a menacing natural hazard to ranchers and rangeland managers alike. Its impact on forage production and water resources have been studied for decades, with many tools to manage and anticipate its impacts emerging from this work. Seasonal climate predictions provide an additional tool to prepare for drought. Those predictions have been improving in recent decades, especially for winter precipitation predictions because of connections with sea surface temperature and pressure anomalies that manifest during El Niño-Southern Oscillation events. However, their limited predictive power in the summer growing season for most regions and coarse spatial resolution have limited their adoption by ranchers and rangeland managers. Therefore, rather than a panacea, seasonal climate predictions are better viewed as only one of many tools to increase preparation for future drought.

## What Are Seasonal Climate Predictions?

Seasonal climate predictions sit at the intersection of weather forecasts that cover the timescale of hours to about 2 weeks and long-term climate projections, which typically extend beyond 1 year and out to a century.<sup>1</sup> Prediction of weather and climate at any timescale is challenging, but this intermediate seasonal timescale of beyond several weeks to about a year brings its own set of challenges. Seasonal climate predictions are structured to examine slowly evolving components of the climate system and then suggest how they may affect the expected average climate for the next month or coming seasons. These slowly varying components of climate include things like sea surface temperatures in the large ocean basins, sea ice and snow cover at higher latitudes, and soil moisture levels over large continental areas.

## The El Niño Southern Oscillation

One of the most reliable climate phenomena used in seasonal climate predictions is tracking and attempting to forecast the state of the El Niño-Southern Oscillation (ENSO). ENSO is a somewhat regular (on the order of 2–7 years) shift in sea surface temperatures along the equator of the Pacific Ocean basin. Normally, temperatures are cooler in the eastern Pacific and warmer in the western Pacific due to easterly winds causing upwelling of cool water in the east and the movement of warmer surface water to the west. In some years, stronger than average easterly winds will intensify this pattern of cool east-warm west sea surface temperatures, which is termed a La Niña event. During El Niño events, these easterly winds weaken, causing warm water to slosh back to the central and eastern Pacific with warmer than average sea surface temperatures in these regions.

The location and extent of warm sea surface temperatures is critical in determining where anomalous tropical convection occurs and, in turn, its impact on global circulation patterns. Across the continental United States, the impact of ENSO is strongest during the winter season when the storm track driven by the position of the jet stream is typically disrupted

evaluated and integrated into this product based on tools past performance and expert judgement.<sup>2</sup> The National Oceanic and Atmospheric Administration Climate Prediction Center (NOAA-CPC) issues a suite of seasonal climate outlooks the third Thursday of each month for the coming month and overlapping 3-month periods to cover a year from the current date. The outlooks include precipitation and temperature information represented in probabilities of observing the seasonal mean (or “normal” for the most recent 30-year normal period) for temperature or total for precipitation falling in one of three categories (tertiles). These tertiles (thirds of the full distribution) represent above (67th–100th percentile), normal (34th–66th percentiles), and below (1st–33rd percentiles) normal conditions based on the historical data for that location.

The outlooks are typically depicted as maps of probability anomalies for each of these three categories. For example, green colors show the shift in odds toward wetter than median conditions, and brown shows a shift in the odds toward drier conditions. Median is used as the measure of central tendency for precipitation rather than average because of the nature of typical precipitation distributions, which often consist of many small values and only a few large values. White colors on the map indicate equal chances of observing total precipitation or

average temperature over this season in any one of the three categories, effectively communicating that there is not enough information to shift the odds in any direction and make a useful forecast.

The 3-month precipitation outlook made in October of 2015 shown in Fig. 2 has a very large shift in odds toward wetter than median conditions across much of the southern states and drier than median conditions across the northern states for the upcoming December to February season. Looking at Arizona in particular, the 50% probability anomaly indicates that there is a 50% chance of seeing above-normal (upper third of the historical distribution) total December to February precipitation, a 33% chance of observing normal (middle third of distribution) precipitation, and only a 16% chance of observing below-normal precipitation over this period. The exact opposite forecast is being made for Montana with a 50% chance of below-median precipitation (bottom third of local distribution) and implicitly a 16% chance of above-median precipitation. In between the dry signal to the north and wet signal to the south is the dreaded equal chances depiction, which indicates that total precipitation between December to February is equally likely to be wetter, drier, or simply near median values.

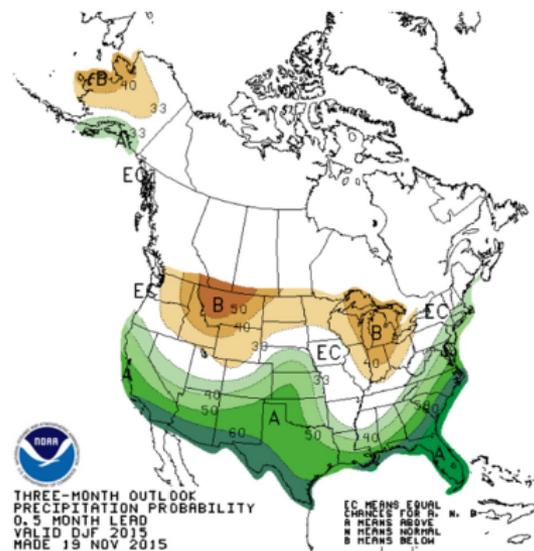


Figure 2. Three-month precipitation outlook made in October 2015 for the December-January-February period (NOAA-CPC).

# Developing new precipitation monitoring strategies for ranchers and range managers



07/26/2016

# Precipitation Logbook Generator

Precipitation Logbook Generator About Tool Choose a location Generate Logbook

## Set location and download data

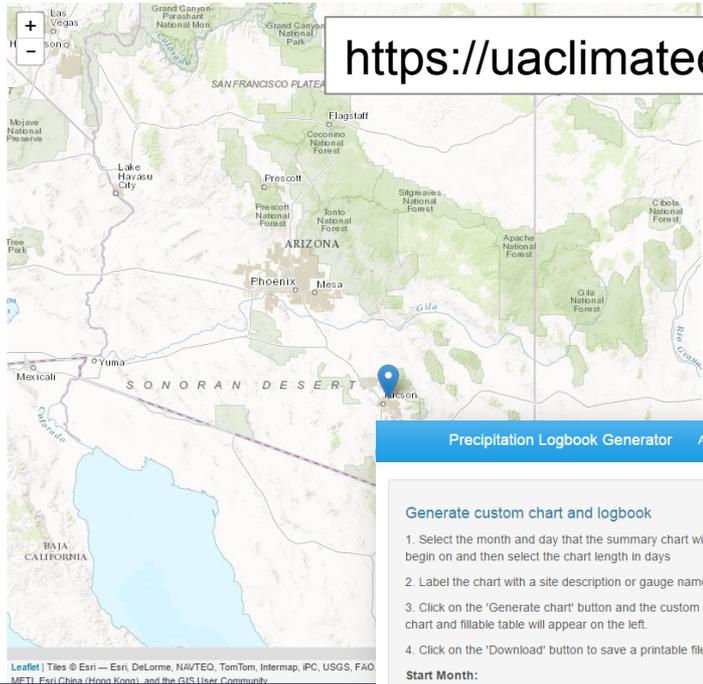
1. Click map to select location (use +/- buttons to zoom, use cursor to pan -- only works for locations within continental U.S.)
2. Click 'Download data' button (this may take a couple of seconds, look to upper right corner for progress message)
3. Proceed to Generate Logbook page

Download data

Selected location

Latitude: 32.268554462148

Longitude: -110.906810760498



<https://uaclimateextension.shinyapps.io/precipChart/>

Precipitation Logbook Generator About Tool Choose a location Generate Logbook

## Generate custom chart and logbook

1. Select the month and day that the summary chart will begin on and then select the chart length in days
2. Label the chart with a site description or gauge name.
3. Click on the 'Generate chart' button and the custom chart and fillable table will appear on the left.
4. Click on the 'Download' button to save a printable file.

Start Month:

6

Start Day:

15

Chart length (days):

120

Site name:

Tucson, AZ

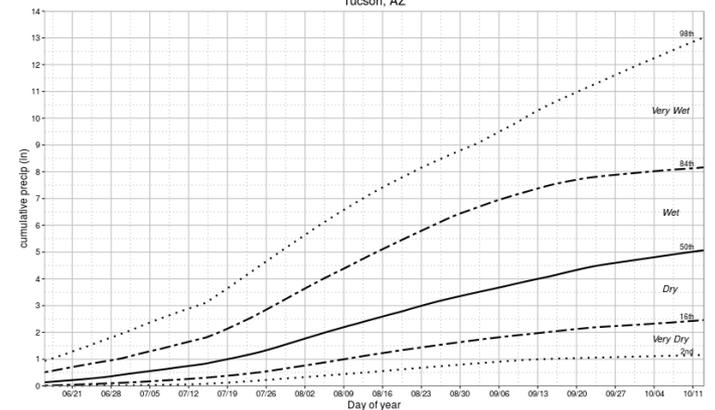
Generate Chart

Download printable chart/table (html file that can be opened and printed with browser)

Download

Cumulative Precipitation Chart

Tucson, AZ



Selected location

Lat: 32.268554462148

Lon: -110.906810760498

Elevation (ft): 2391.7

Center of data grid cell

Lat: 32.25

Lon: -110.916667

Elevation (ft): 2428

Distance between selected location and center of grid cell (ft): 7407

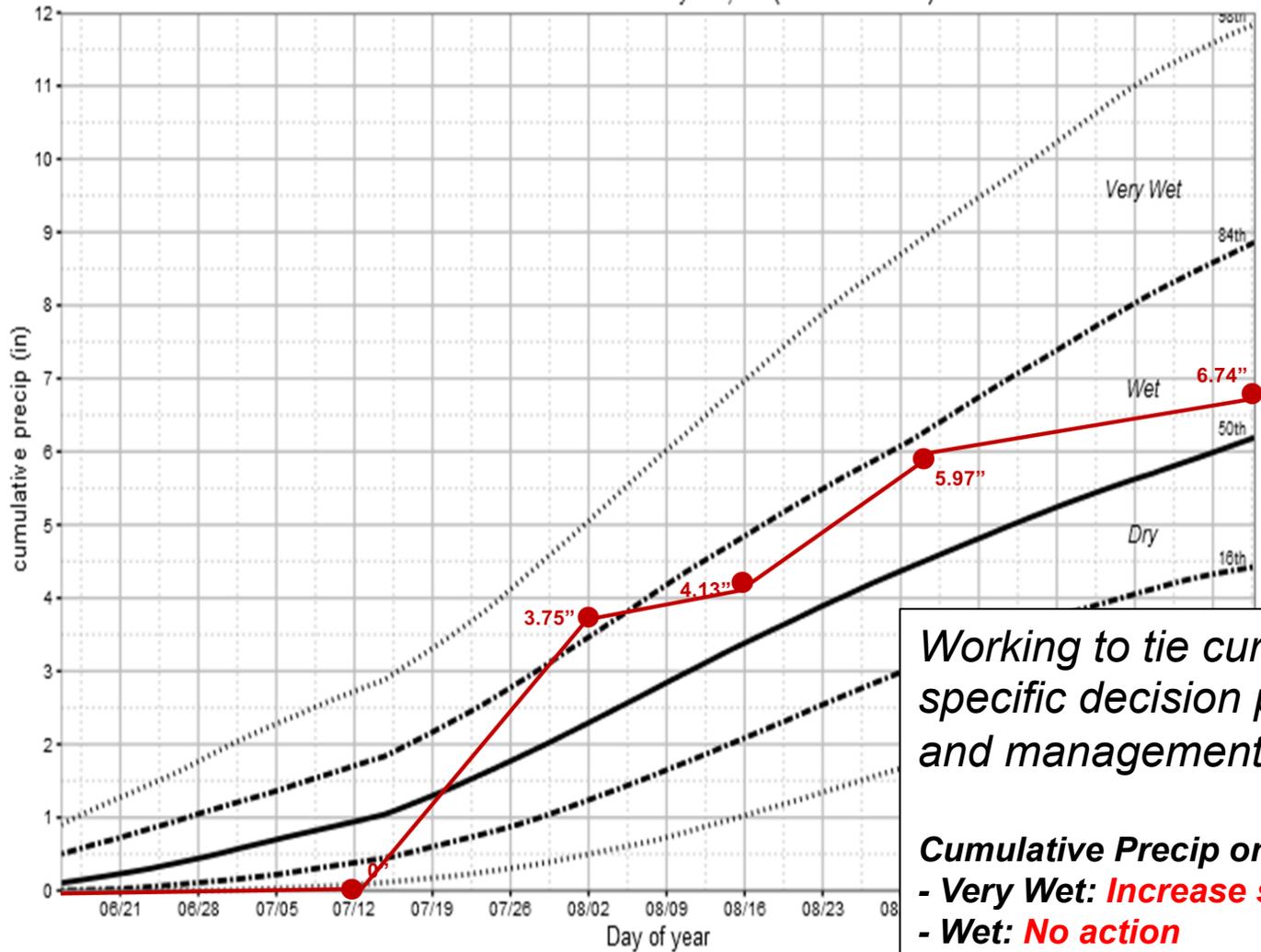


# Printable logbook for tracking precipitation depth locally

## Precipitation Logbook

Tucson, AZ

Mazatzal Hotel & Casino - Payson, AZ (with 2012 data)



*Working to tie curves to specific decision points and management actions*

**Cumulative Precip on Aug 3<sup>rd</sup>**

- Very Wet: **Increase stocking**
- Wet: **No action**
- Dry: **Increase monitoring**
- Very Dry: **supplement feed/ water; relocate cattle**

08-23	0.01	0.07
08-24	0.01	0.08
08-25	0.01	0.09
08-26	0.01	0.09
08-27	0.02	0.10



# Thanks!

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

