Climate Change & Variability, It's Happening

Jeanine Jones, California Department of Water Resources

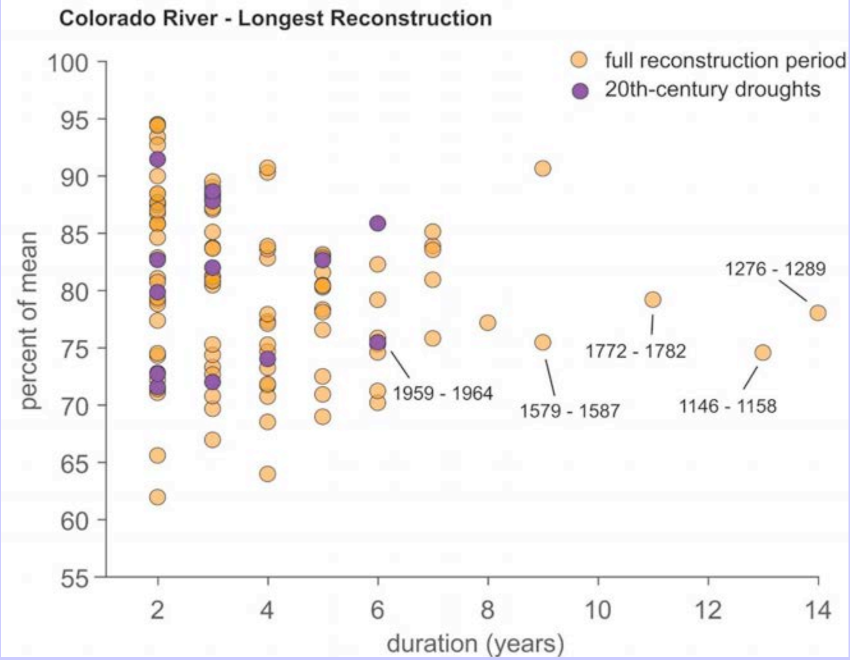
The Climate It Is a Changin’

(apologies to Bob Dylan)

Come gather 'round people
Wherever you roam
And admit that the waters
Around you have grown
And accept it that soon
You'll be drenched to the bone.
If your time to you
Is worth savin'
Then you better start swimmin'
Or you'll sink like a stone
For the times they are a-changin'.

A Changing Climate?

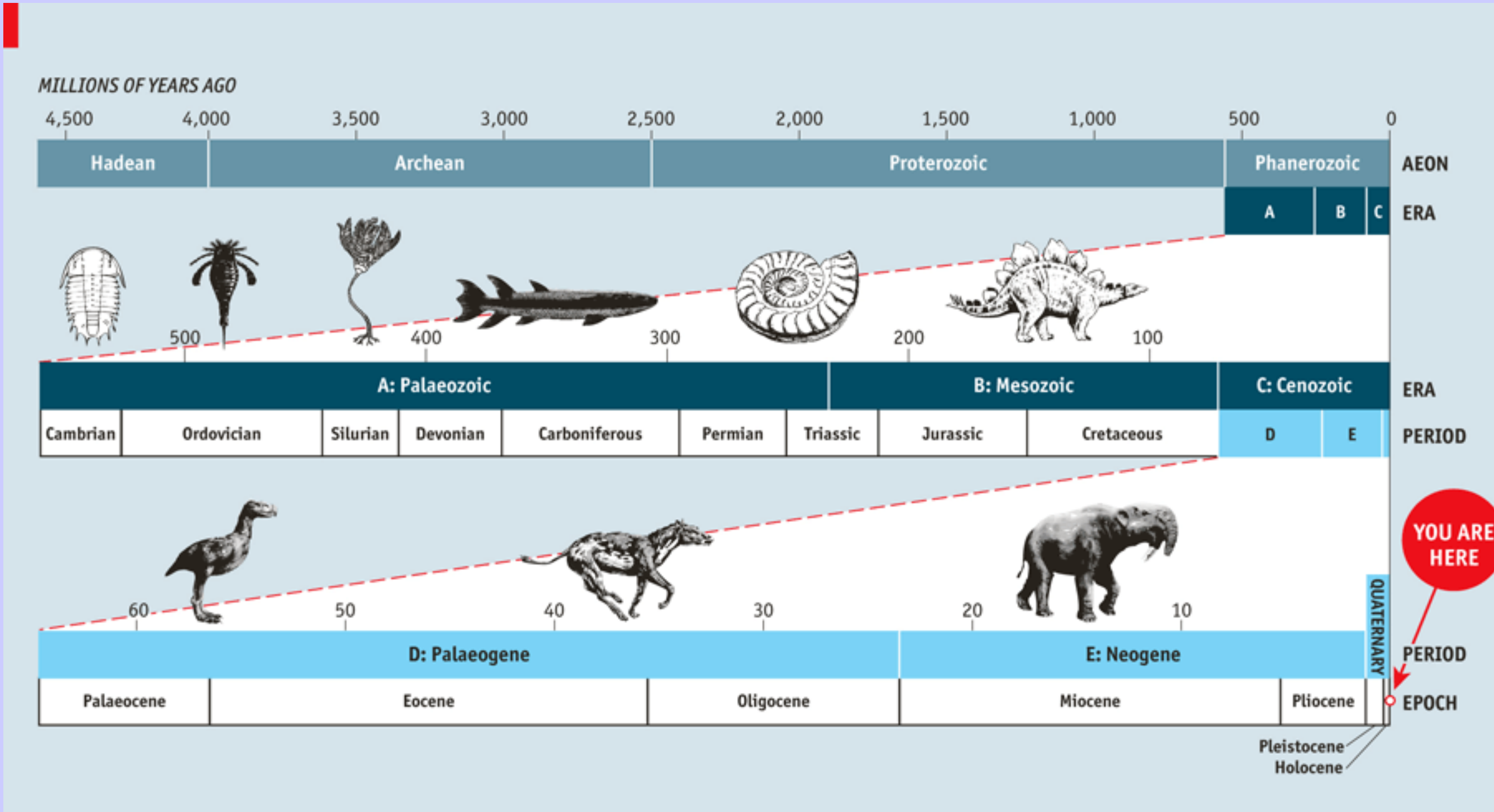
- Over what time period?
- Where?
- And at what time scale?
- **Each of these questions has implications for water management**



Meko et al., 2017

Report prepared by Meko et al. (2017) for CDWR

- *One of the most notable findings in this assessment is that, over the 20th and 21st centuries, southern California precipitation and streamflow … have been more variable with correspondingly less year-to-year persistence, than over the past six centuries.*
- *The variance of Colorado River flows, in contrast, has been low in a long-term context, although the past century was among the wettest centuries of the past 600 years.*



Source: The Economist

Ordovician

What climate period are we planning for?

(We are sampling an infinitesimal piece of a very small part of a much longer climate record!)

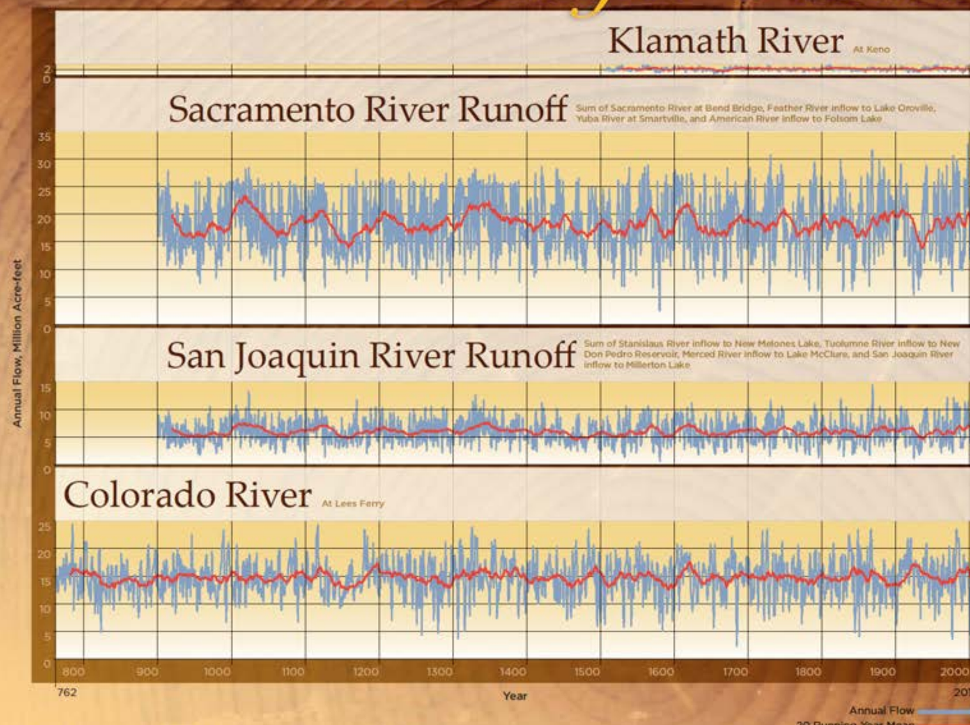
Pleistocene

Earlier in the Holocene….

- Prolonged periods of severe drought occurred in California’s Sierra Nevada circa 4,000 and 6,000 years ago
- Relict tree stumps remain in locations such as Lake Tahoe

National Geographic Photo

Reconstructed Streamflows & Drought Periods



USING TREE-RINGS TO RECONSTRUCT STREAMFLOW

A tree-ring reconstruction is a set of tree-ring width data that have been calibrated with an instrumental or gaged record of a hydrologic or climatic variable such as annual streamflow or precipitation. The reconstruction, based on a statistical model that describes the relationship between tree growth and the gage record, extends that record back hundreds of years into the past.

Tree growth in dry climates is limited by water availability. Trees that provide the best information about hydroclimatic variability are those particularly sensitive to variations in moisture. These include species such as blue oak, ponderosa pine, Douglas fir, and western juniper, usually growing at lower elevations in sparse stands on dry and rocky sites where soil moisture storage is minimal.

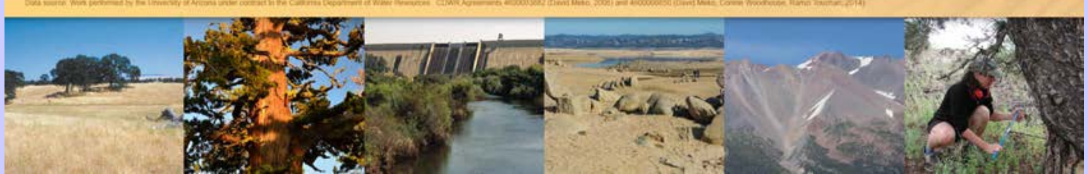
Tree-ring reconstructions of hydroclimatic variables are developed from tree-ring chronologies. A tree-ring chronology is a time-series of annual values derived from the ring-width measurements of 10 or more trees of the same species at a single site. To create a tree-ring chronology, cores from the sampled trees at each site are cross-dated (i.e., patterns of narrow and wide rings are matched from tree to tree) to account for missing or false rings, so that every annual ring is absolutely dated to the correct year. Then all rings are measured to the nearest thousandth of a millimeter using a computer-assisted measuring device. After growth-related trends unrelated to climate are statistically removed, the ring width values from all sampled trees for each year are averaged to create a time series of annual ring width indices. The complete series of ring width indices from a site is called a tree-ring chronology.

Once a gaged record of interest is selected for reconstruction, a set of tree-ring chronologies from the region near the gage is calibrated with the gage record to form a reconstruction model. A statistical technique called multiple linear regression is commonly used. The reconstruction is evaluated by comparing the observed gage values with the reconstructed values by assessing the amount of variance in the gage record that is explained by the reconstruction.

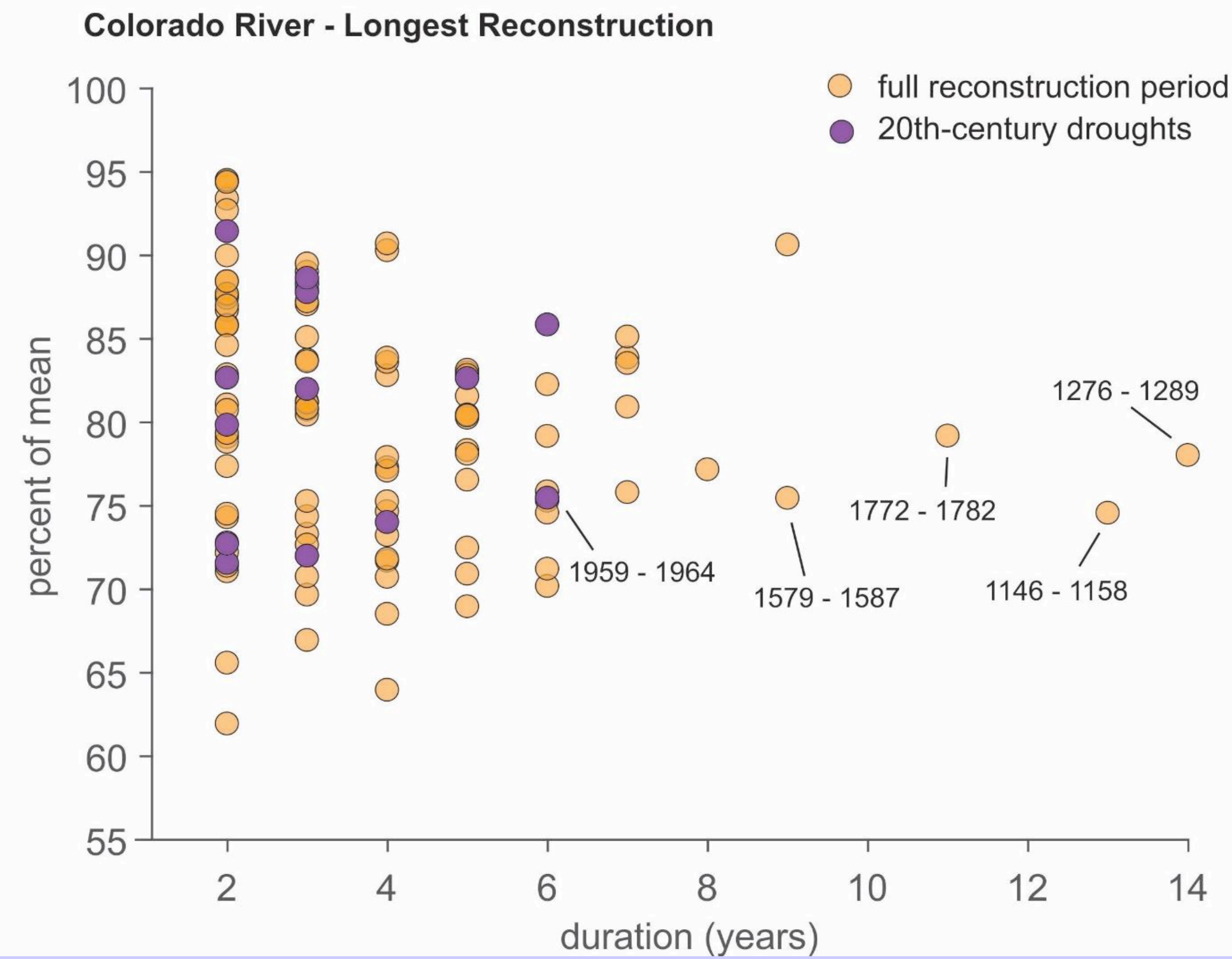
DROUGHTS PRIOR TO THE HISTORICAL RECORD

The period of reliably measured streamflows for rivers throughout the West seldom reaches beyond 100 years, which represents only a fraction of climatologically modern time. As these streamflow reconstructions show, there have been droughts prior to the historical period that were more severe - particularly in duration - than those in the measured record. The reconstructed record captures a broader range of hydrologic variability than does the historical record, making reconstructions useful for drought preparedness planning. Of particular interest from a scientific perspective is the Medieval Climate Anomaly, a time during which sustained severe drought gripped much of the western United States, as exemplified illustrated in the Sacramento, San Joaquin, and Colorado River reconstructions.

Data source: Work performed by the University of Arizona under contract to the California Department of Water Resources. CDWR Agreements 4600003682 (David Meko, 2006) and 4600008850 (David Meko, Connie Woodhouse, Ramzi Touchan, 2014)

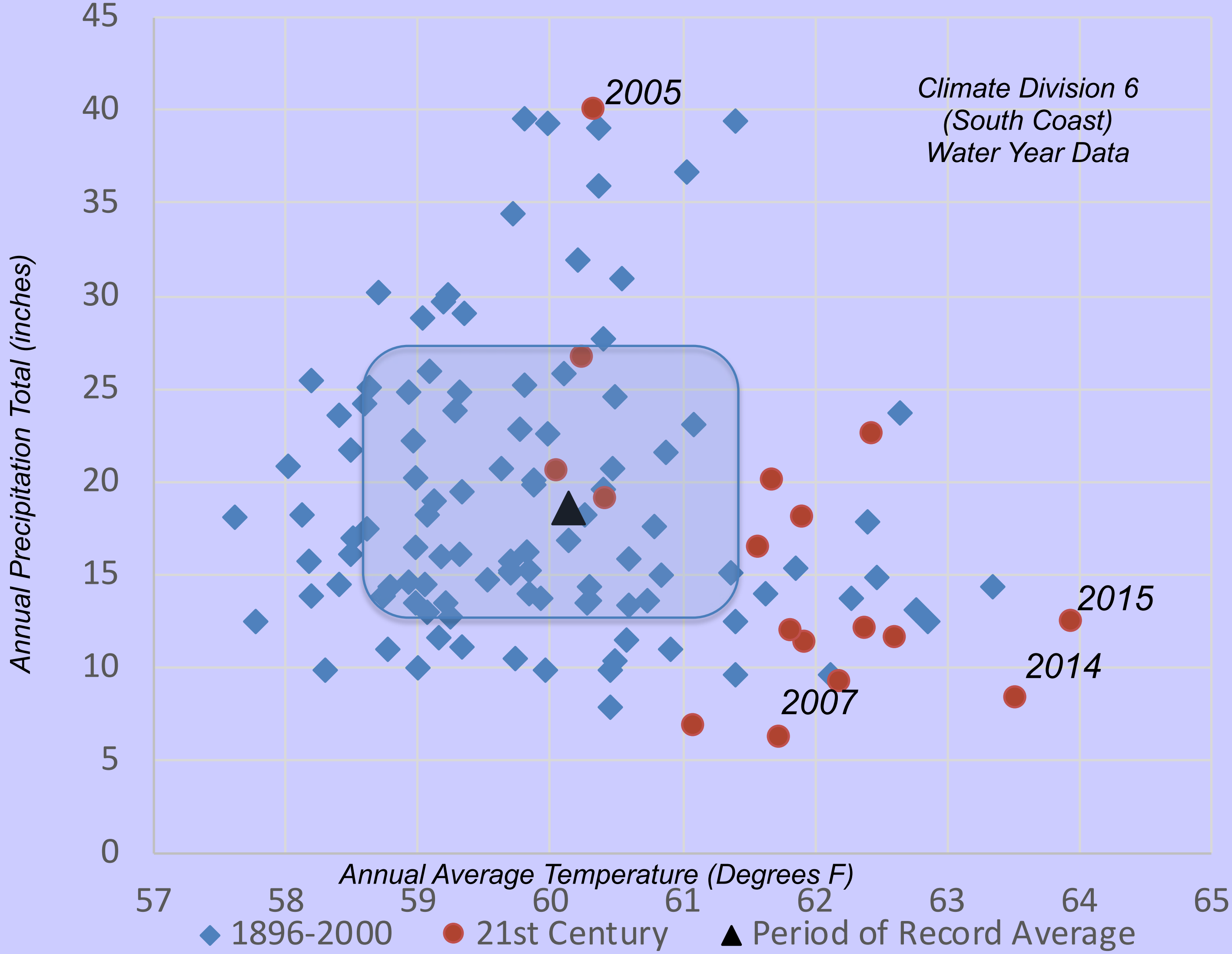


Drought Periods Based on Reconstructed Streamflow at Lees Ferry



Meko et al., 2017

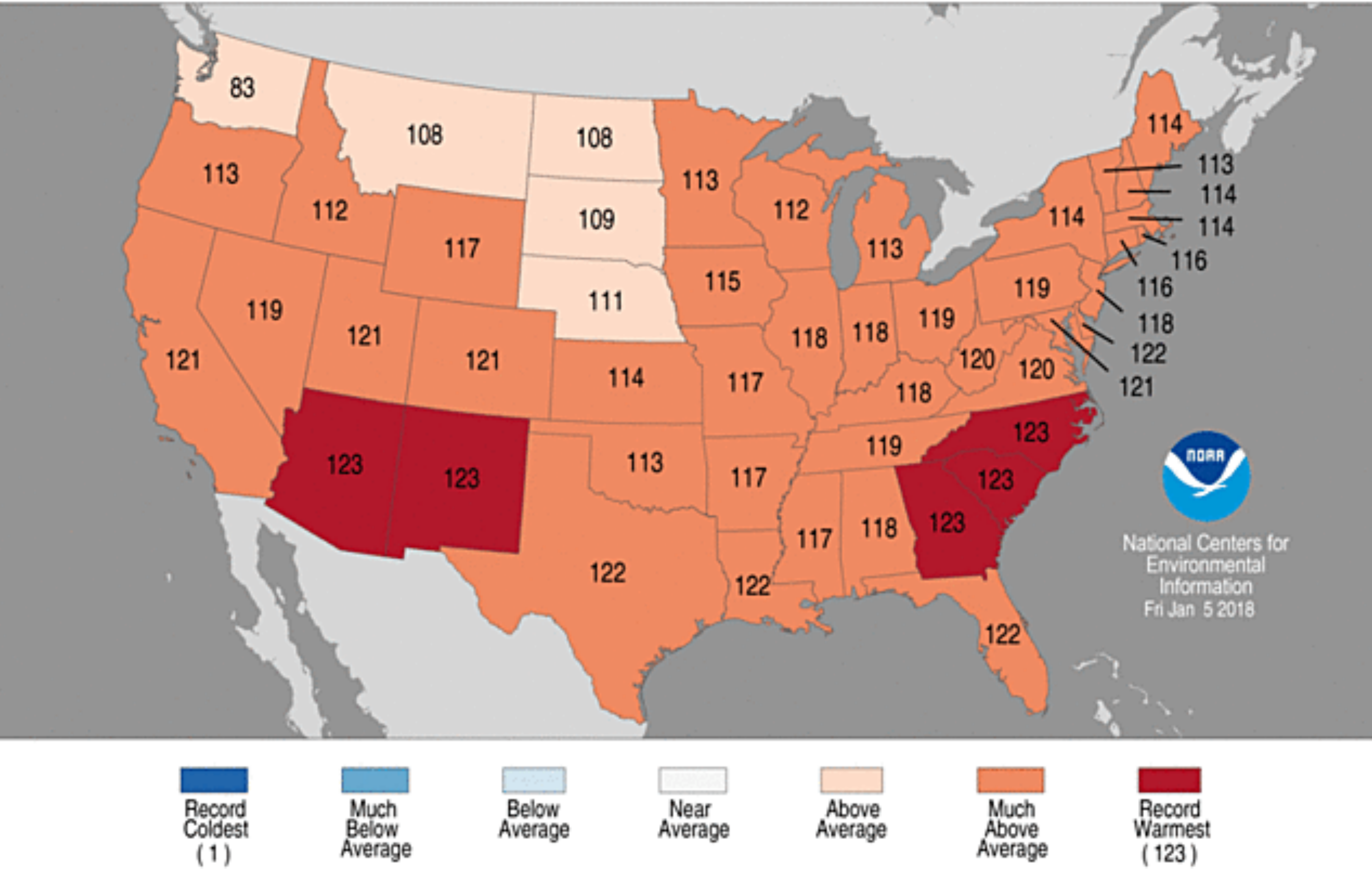
Fast-Forward to the 21st Century – Southern California Example



Statewide Average Temperature Ranks

January–December 2017

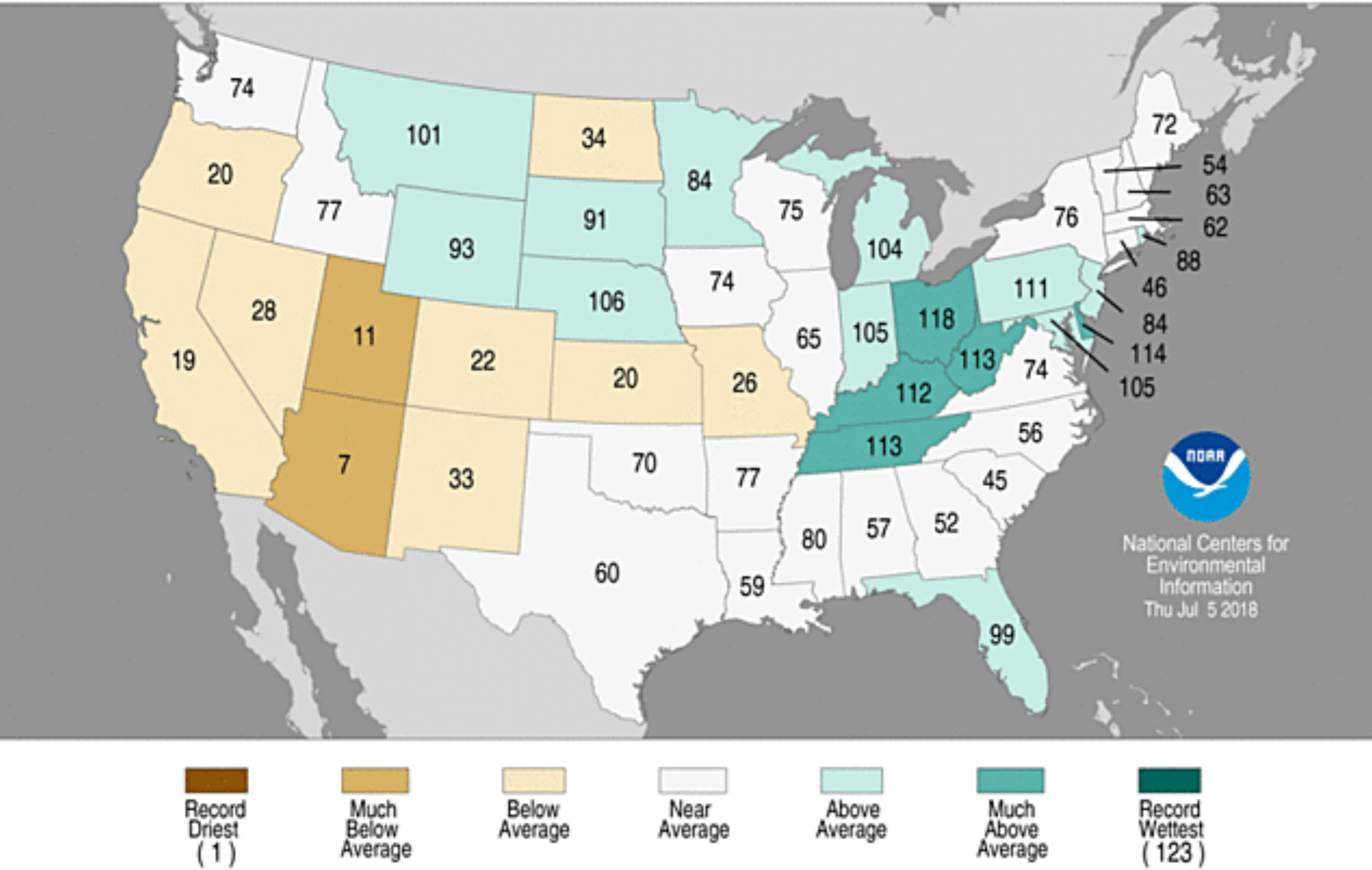
Period: 1895–2017



Statewide Precipitation Ranks

July 2017–June 2018

Period: 1895–2018



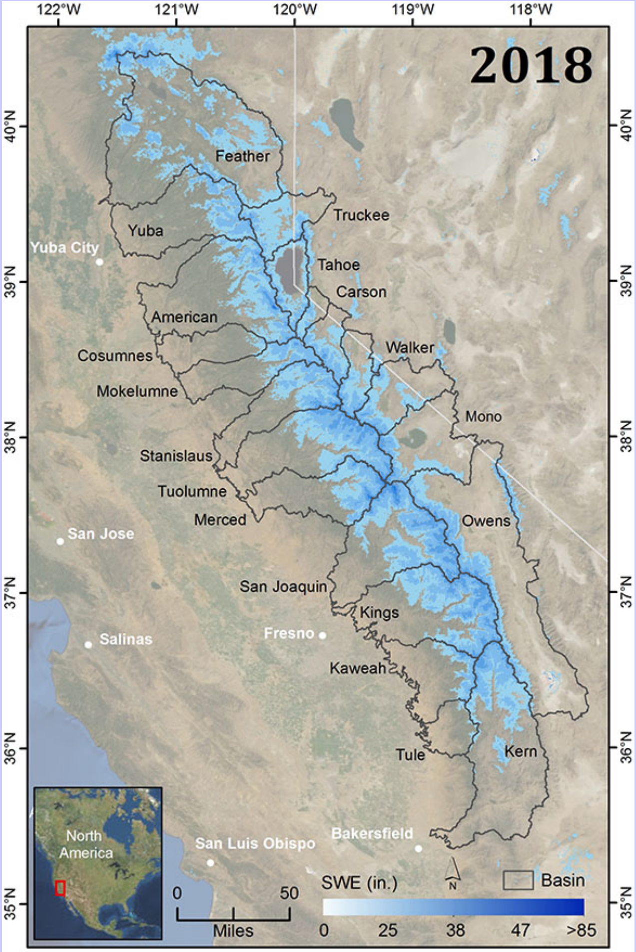
California's Water Year 2018

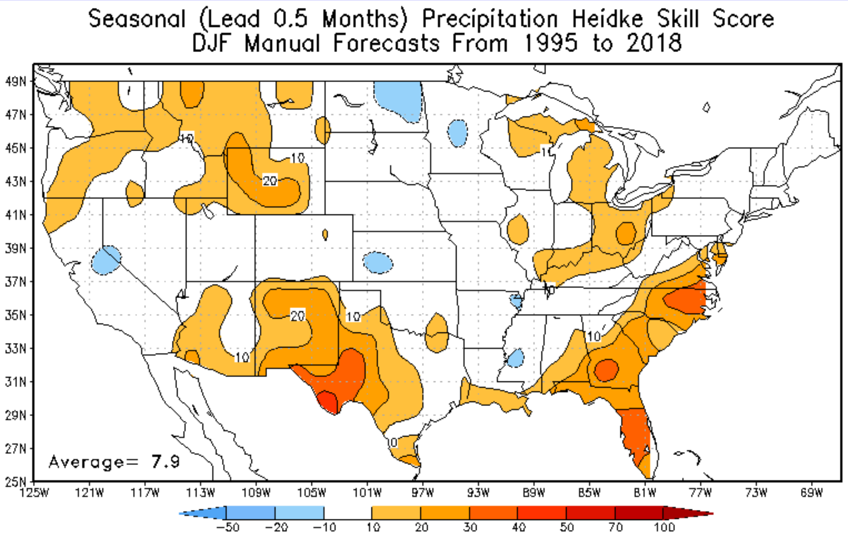
- Hot, dry, and on fire!
- New records set for wildfire damages, records already broken as Water Year 2019 began
- Water Year 2018 preceded by a Water Year 2017 that was 2nd wettest on record (based on statewide runoff); BUT all except 2 years in the decade prior to 2017 were drought years….

Implications for Water Agency Planning

- Most Western water infrastructure designed based on short period of observed record, design criteria may not capture range of natural variability or anthropogenic climate change
- Plan for greater variability!
- Better observing and forecasting systems needed to support climate adaptation (e.g., high-elevation snowpack monitoring, developing skill in sub-seasonal to seasonal precipitation forecasting)
- Must prepare for previously unexpected impacts, e.g., wildfire

Improved Monitoring & Forecasting Needed





Wildfires Caused Significant CA Water Infrastructure Damage in WYs 2017-19


110
100
90
80
70
60
50
40
30
BAKER
CA.
GATEWAY
TO
DEATH
VALLEY
WORLD
FAMOUS
Now Open
Gift Shop