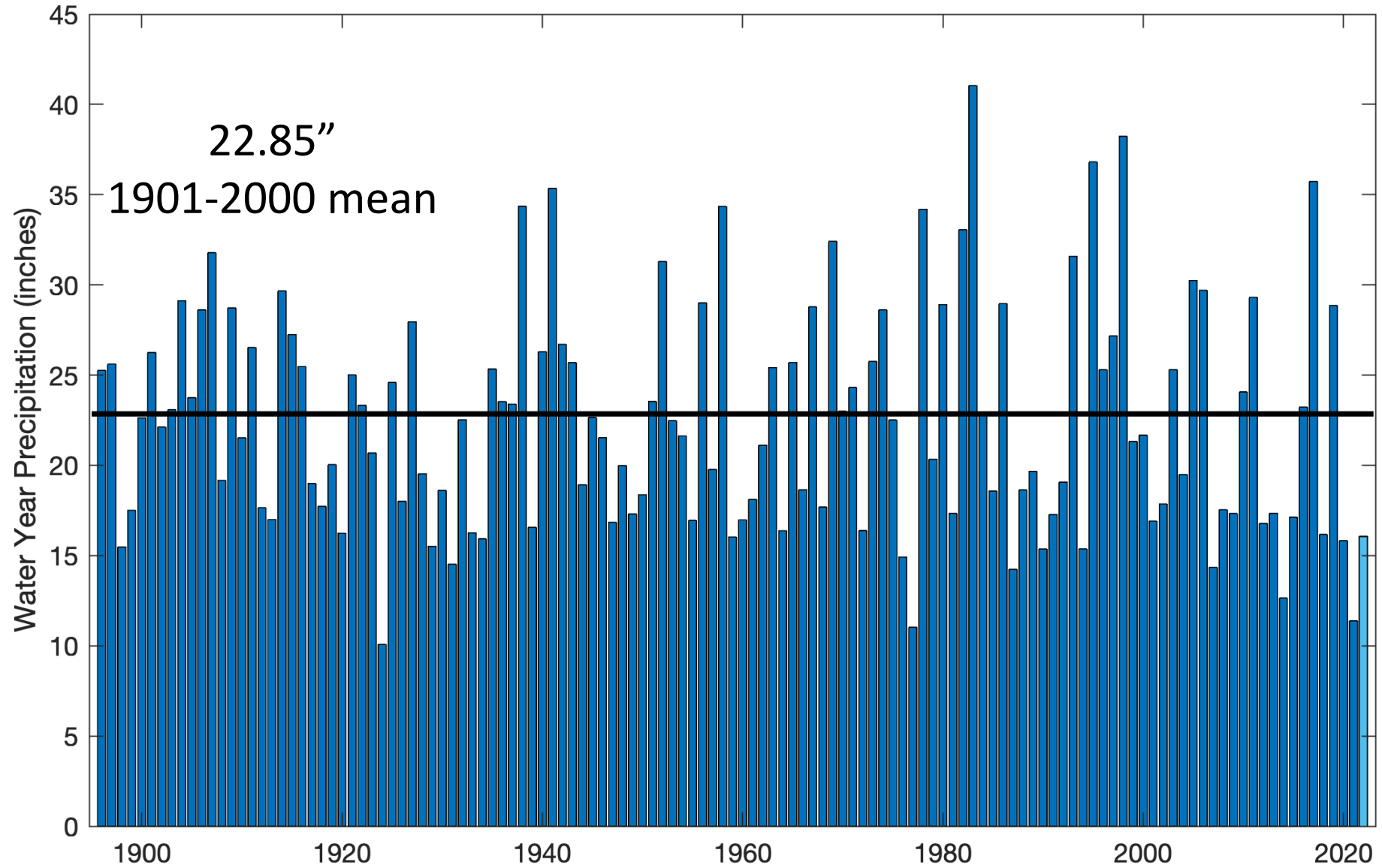


# Our Never-ending Drought?

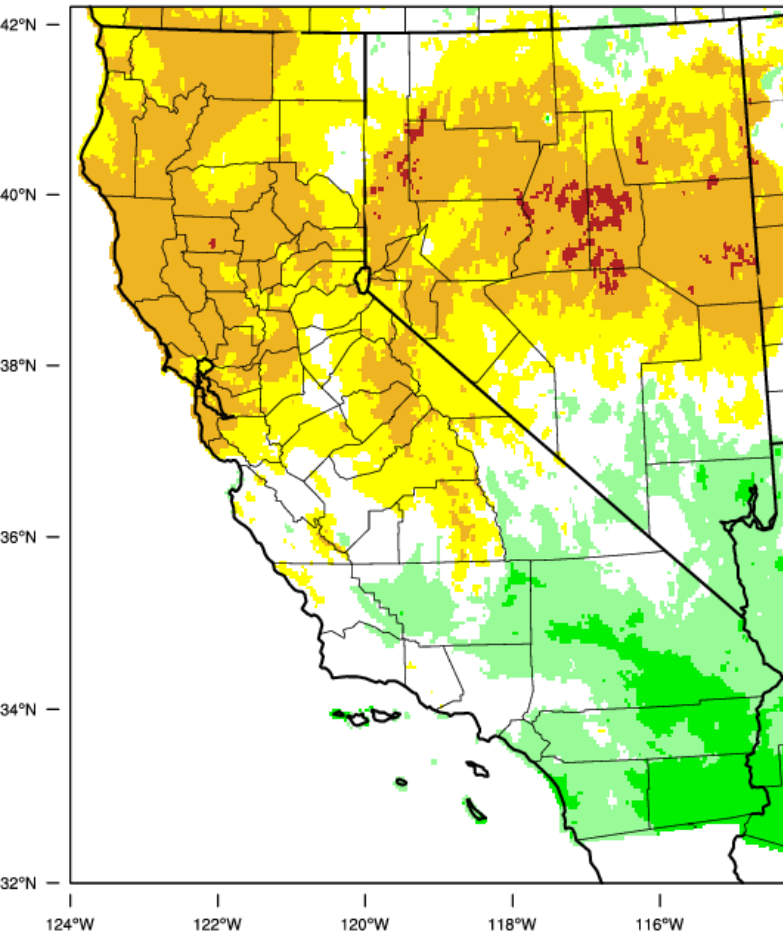


John Abatzoglou

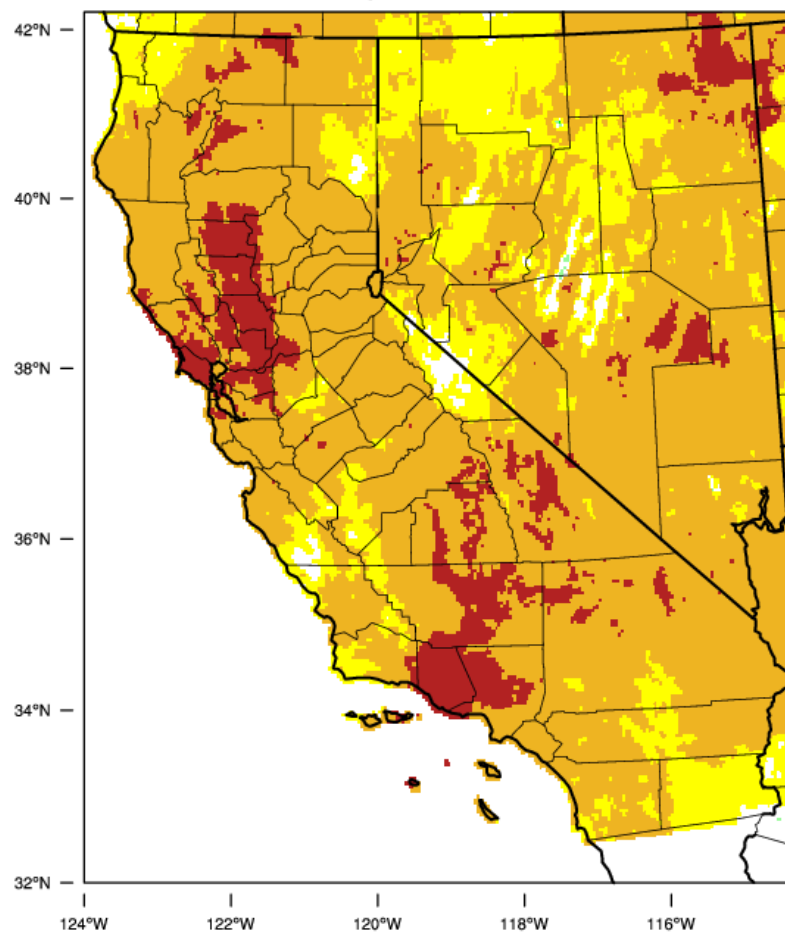
# California's Volatile Precipitation



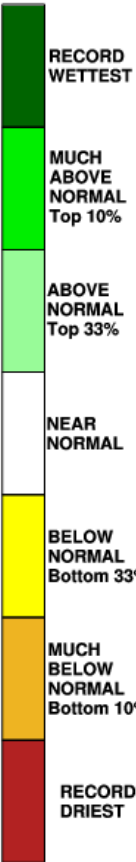
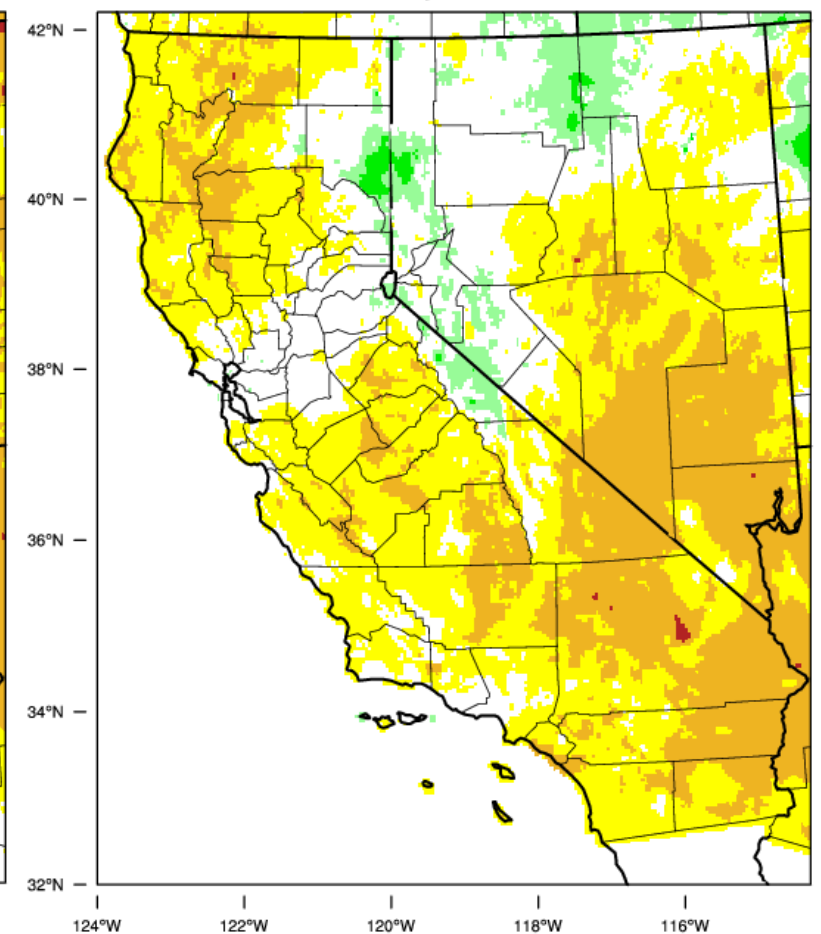
**California - Precipitation**  
October-June 2020 Percentile



**California - Precipitation**  
October-September 2021 Percentile



**California - Precipitation**  
October-May 2022 Percentile



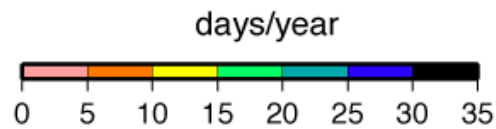
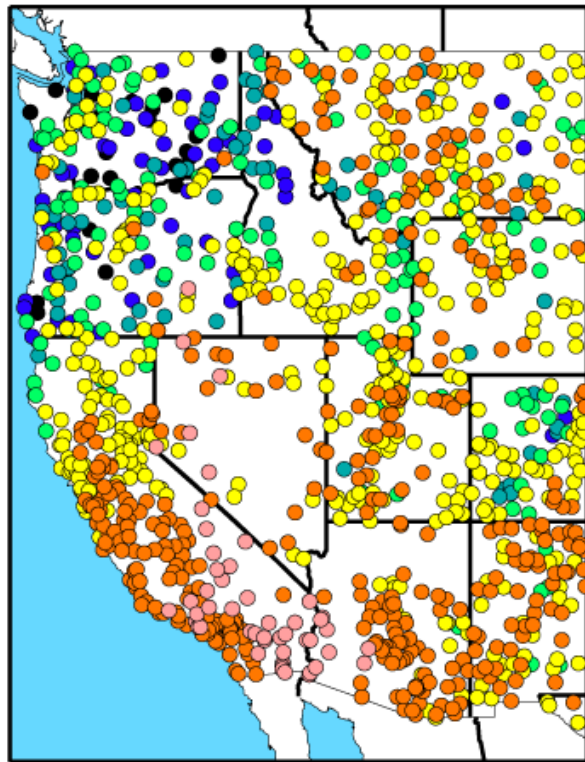
WestWide Drought Tracker, U Idaho/WRCC Data Source: PRISM (Final), created 5 JAN WestWide Drought Tracker, U Idaho/WRCC Data Source: PRISM (Prelim), created 16 OCT WestWide Drought Tracker, U Idaho/WRCC Data Source: PRISM (Prelim), created 16 JUN 2022

## Sonoma County

Missing 1.4 years worth of precip since May 2019

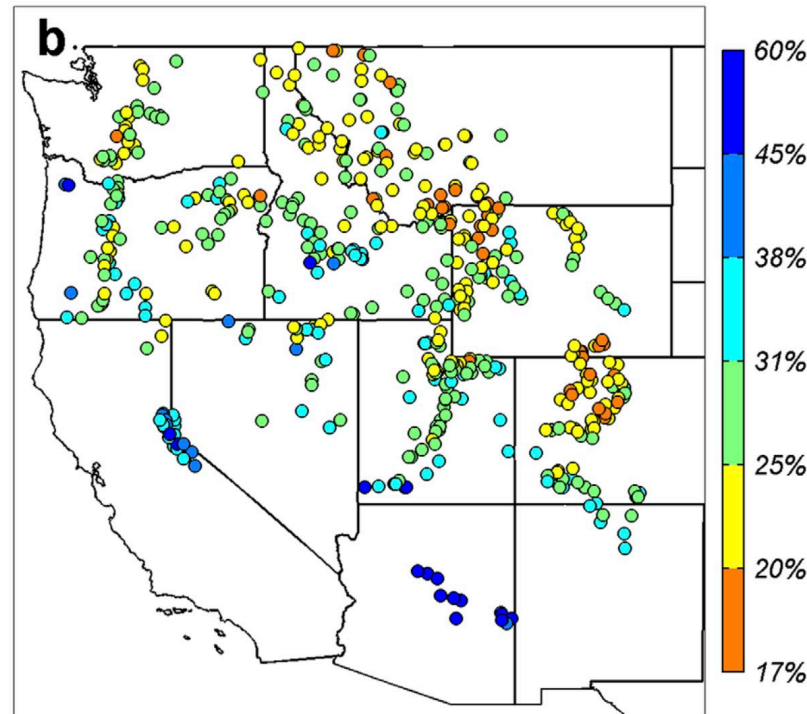
# The Homerun hitter

Number of days to get half annual precipitation



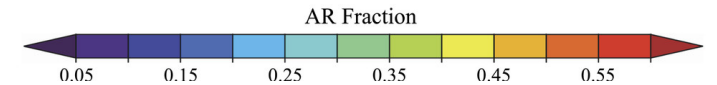
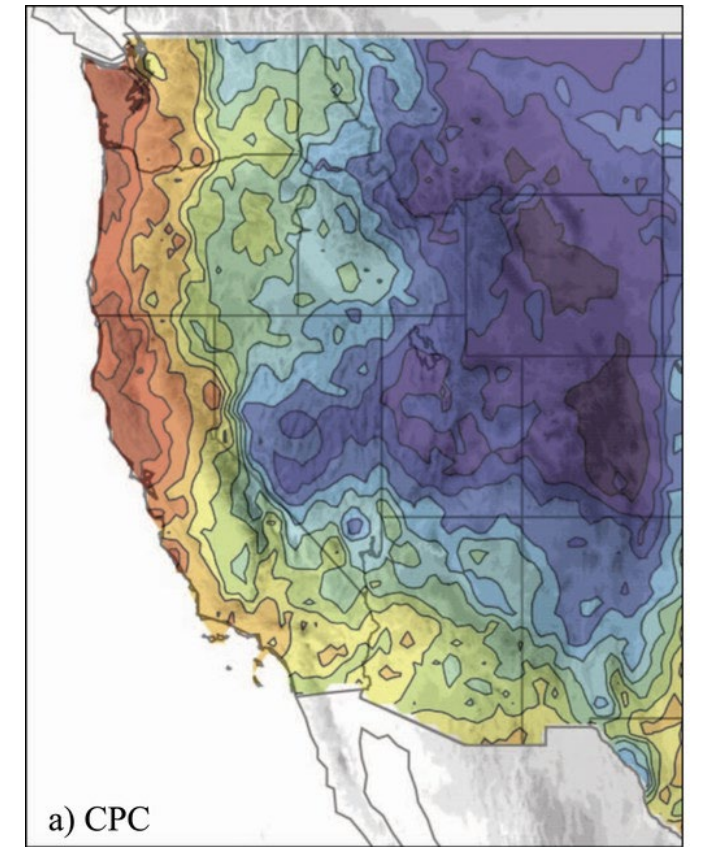
Dettinger et al, 2011

Percent of annual snowfall in top 3 events annually



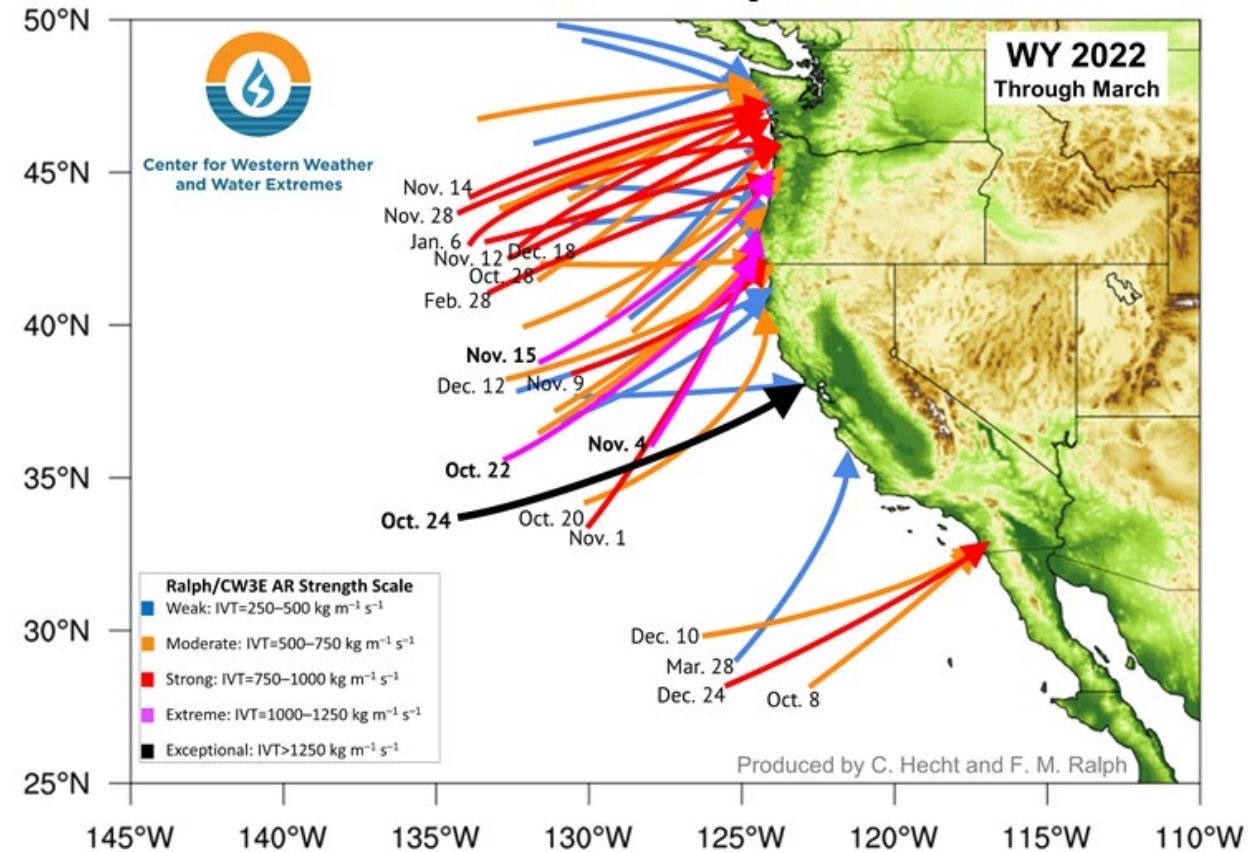
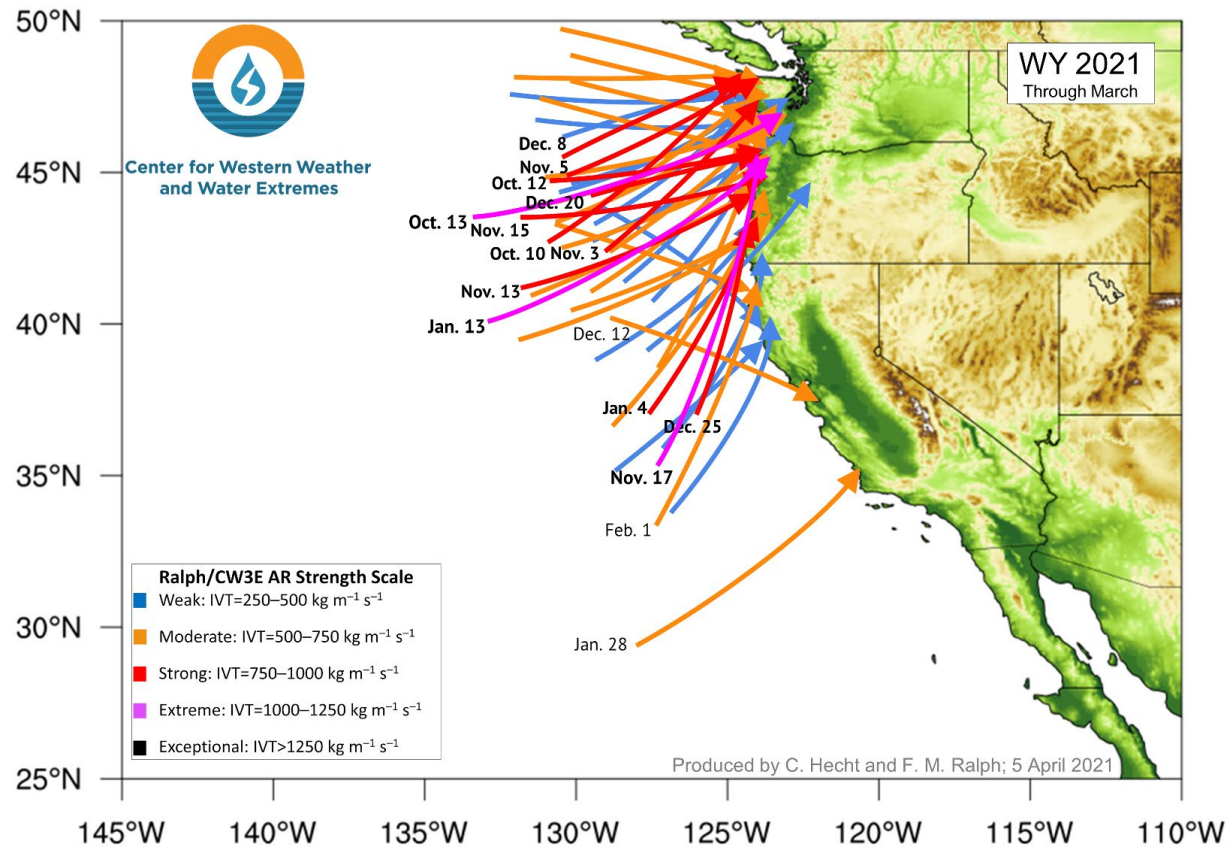
Lute and Abatzoglou, 2014

Fraction of precipitation during atmospheric rivers



Rutz et al., 2014

# Landfalling Atmospheric Rivers WY 21' + 22'

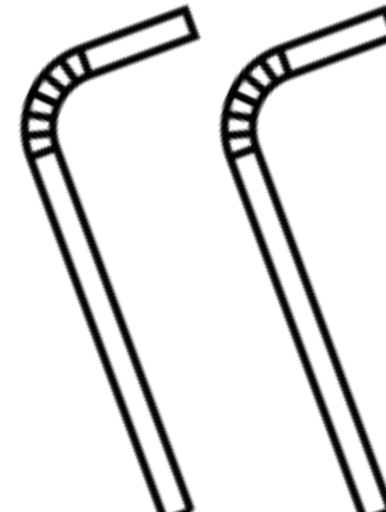


# Evaporative Demand

- Maximum amount of water that could be evaporated and transpired from plants
- Warmer air leads to higher vapor pressure deficit and demand

## Impacts

- increased vegetation thirst
- reduced streamflow
- increased crop water demand



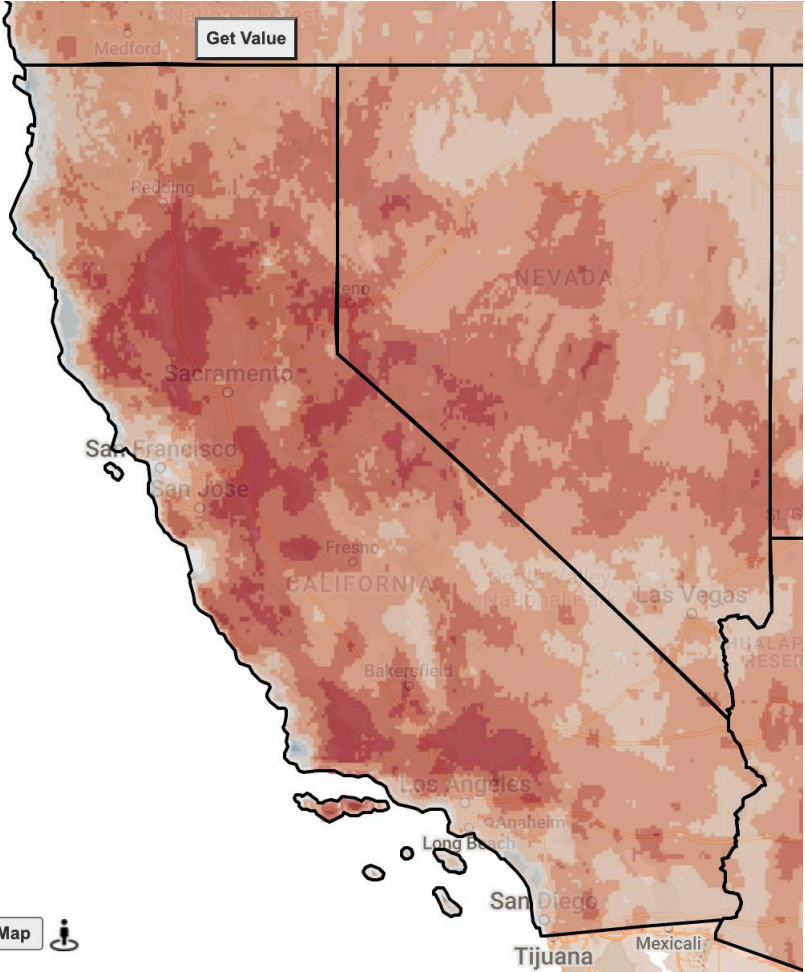
# Rising Evaporative Demand

Slope of Trend in Grass Reference ET (gridMET)



Oct 1 to Sep 30, Total, 1980 - 2021, Sen's slope

Grass Reference ET Trend (in/year)

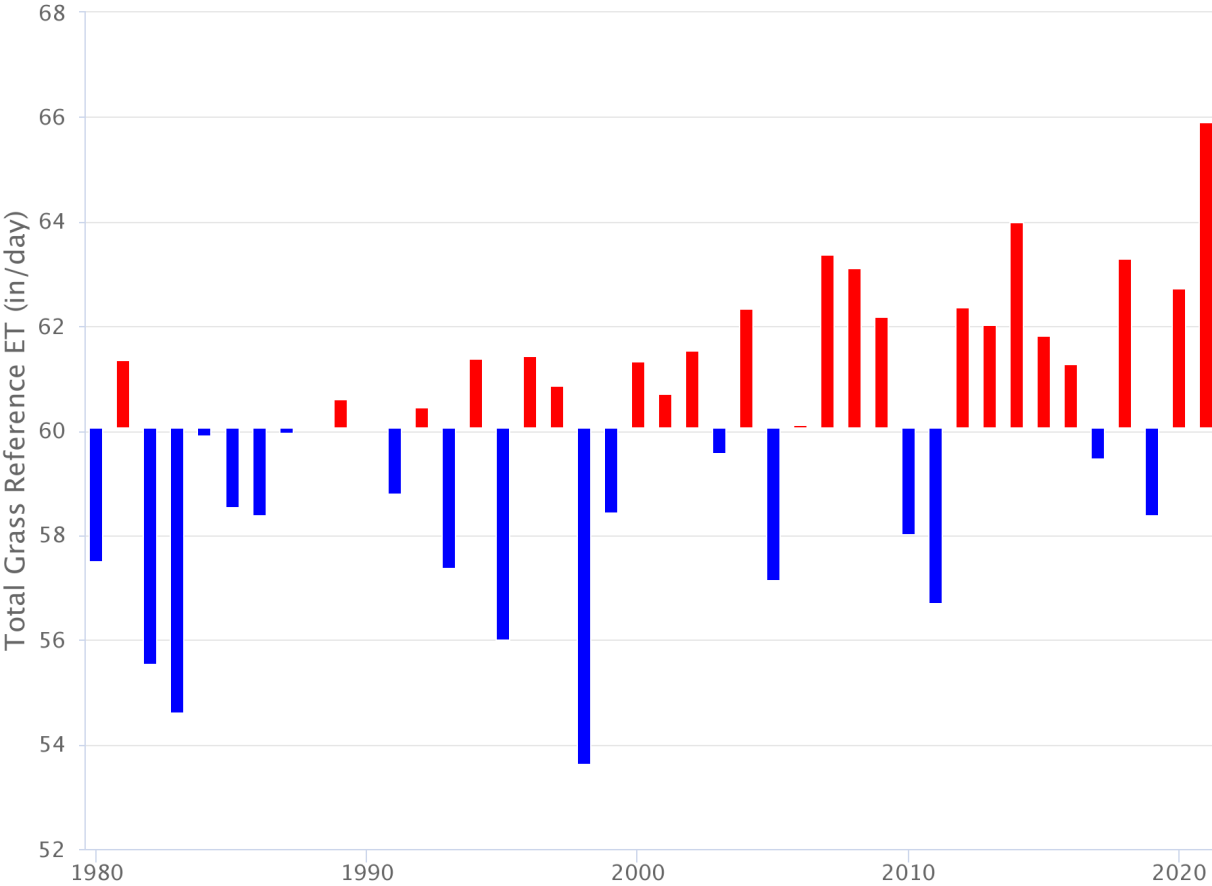


Keyboard shortcuts | Map data ©2022 Google, INI

Generated by ClimateEngine.org

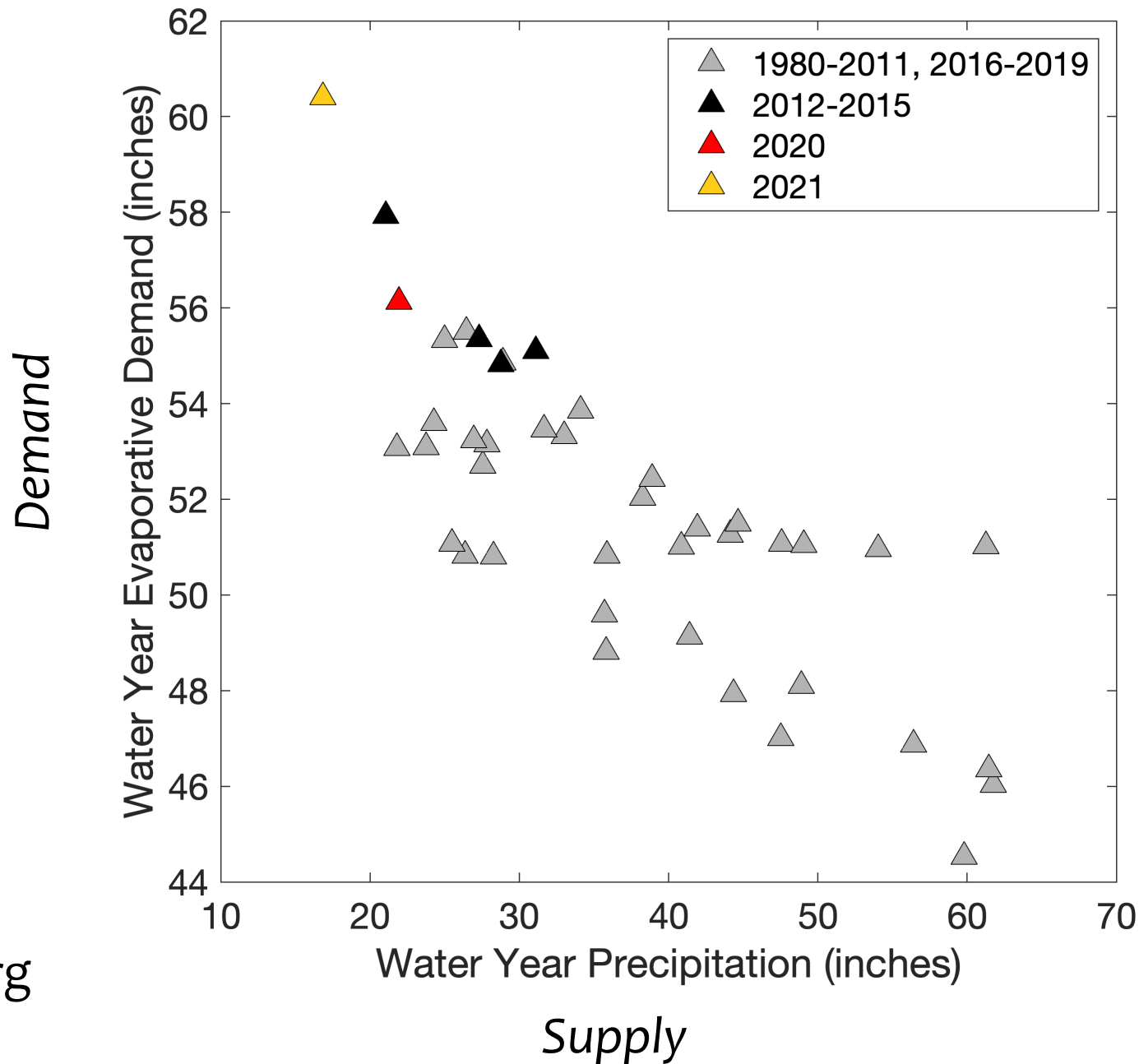
Grass Reference ET (gridMET)

Annual Total for Oct 1 to Sep 30



Generated by ClimateEngine.org

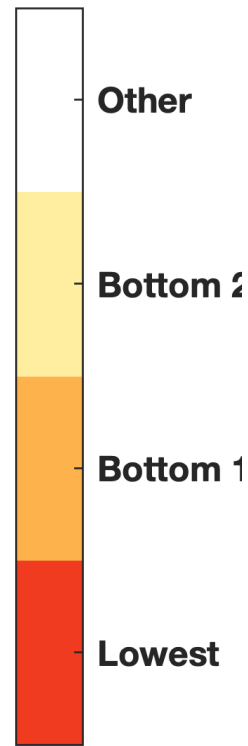
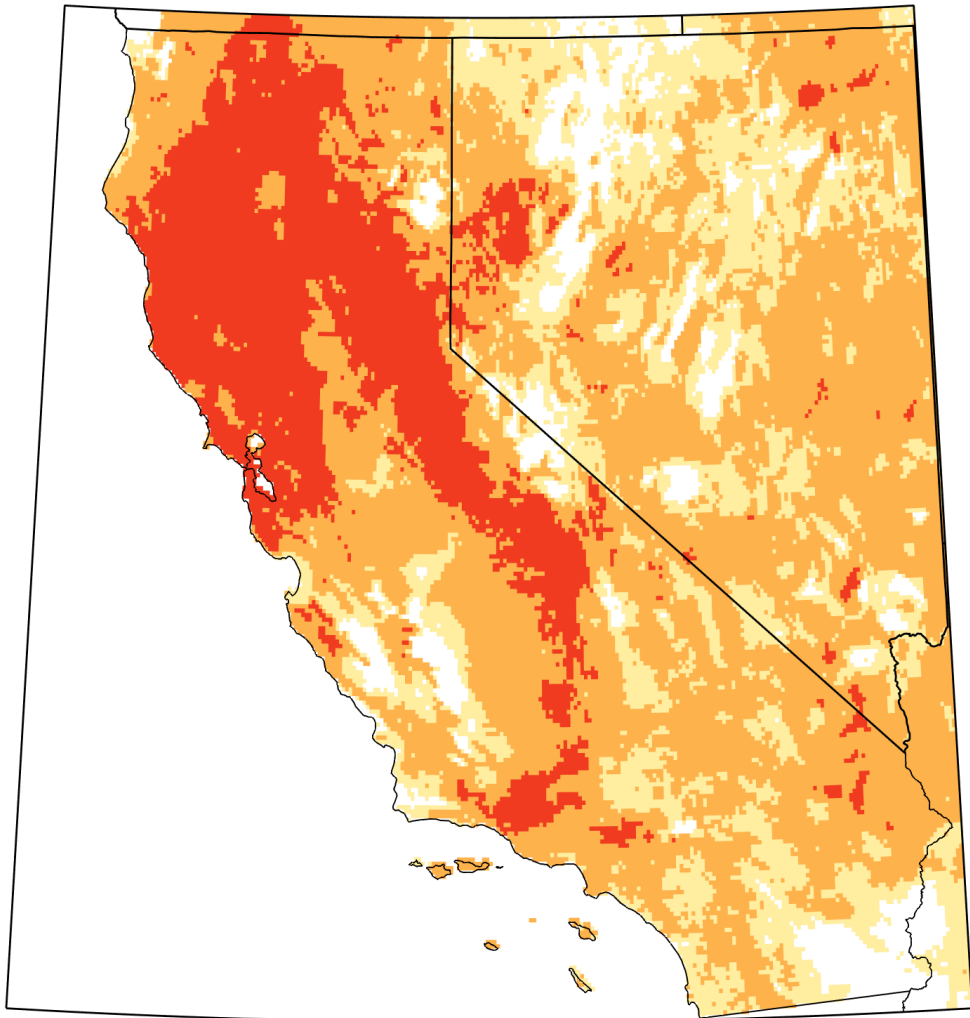
# Upper Sacramento Basin



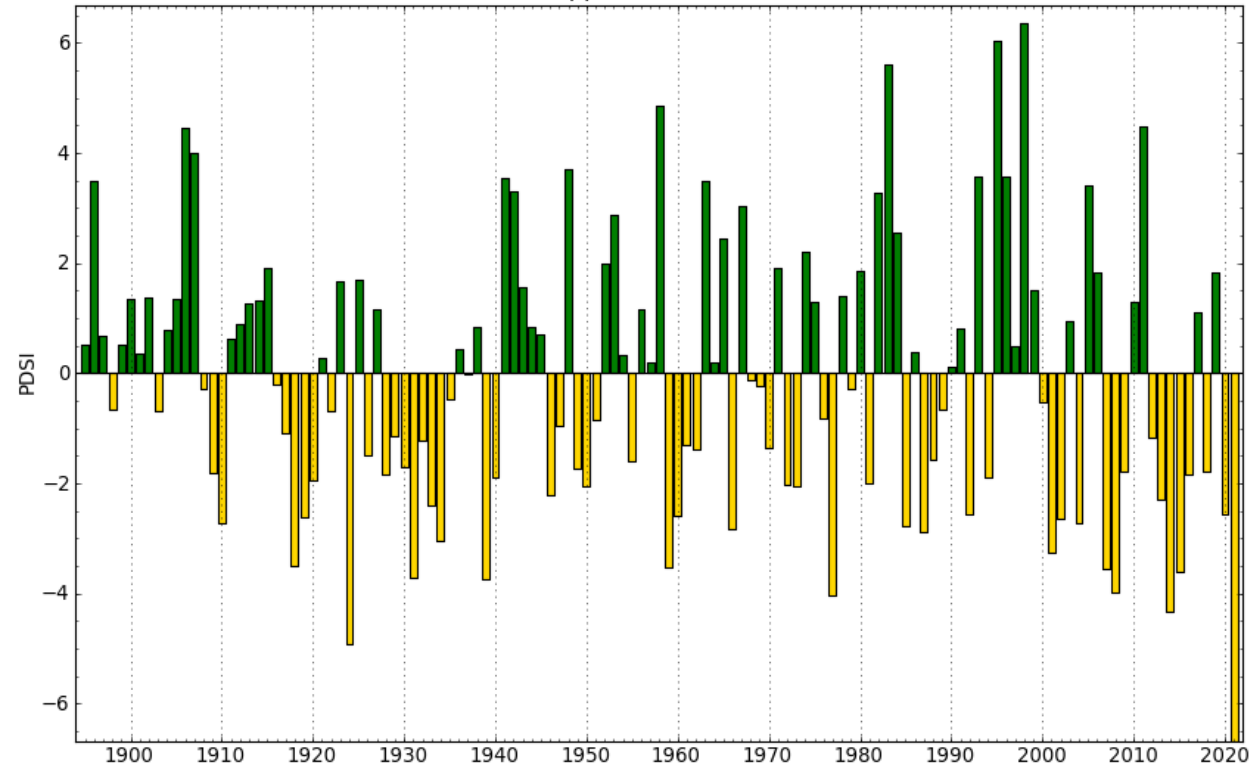


# 'Worst' on record?

## Palmer Drought Severity Index



Palmer Drought Severity Index, 1-Months Ending in August  
Upper Sacramento



Data Source: WRCC/UI, Created: 9-07-2021

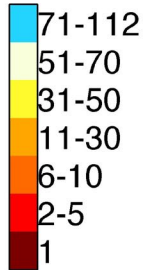
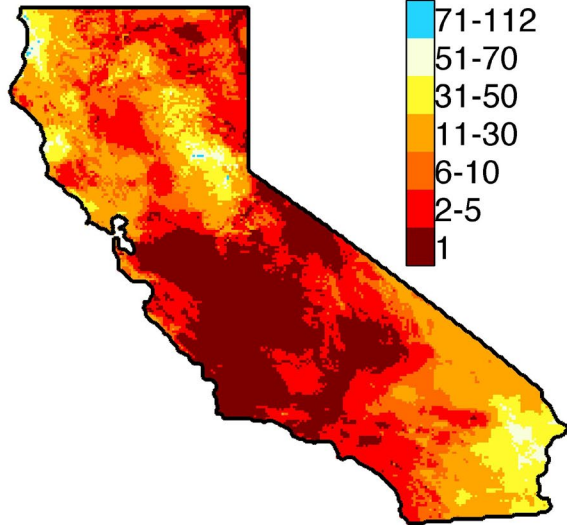
# Climate Change + Drought



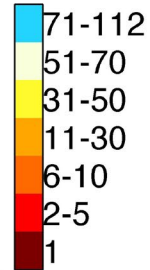
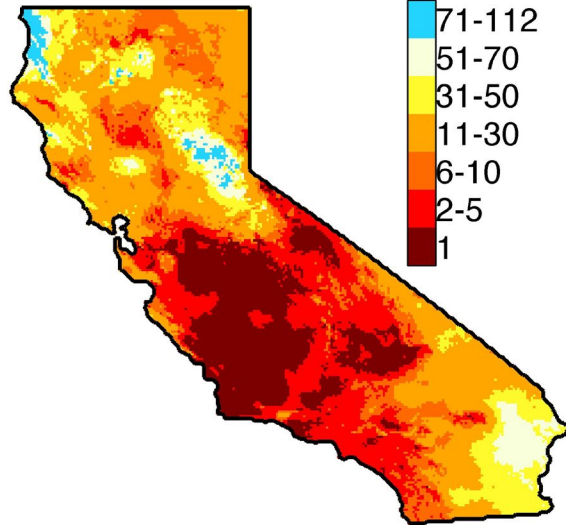
# Climate Change is a Drought Magnifier

2012-2014 drought rank

Observed

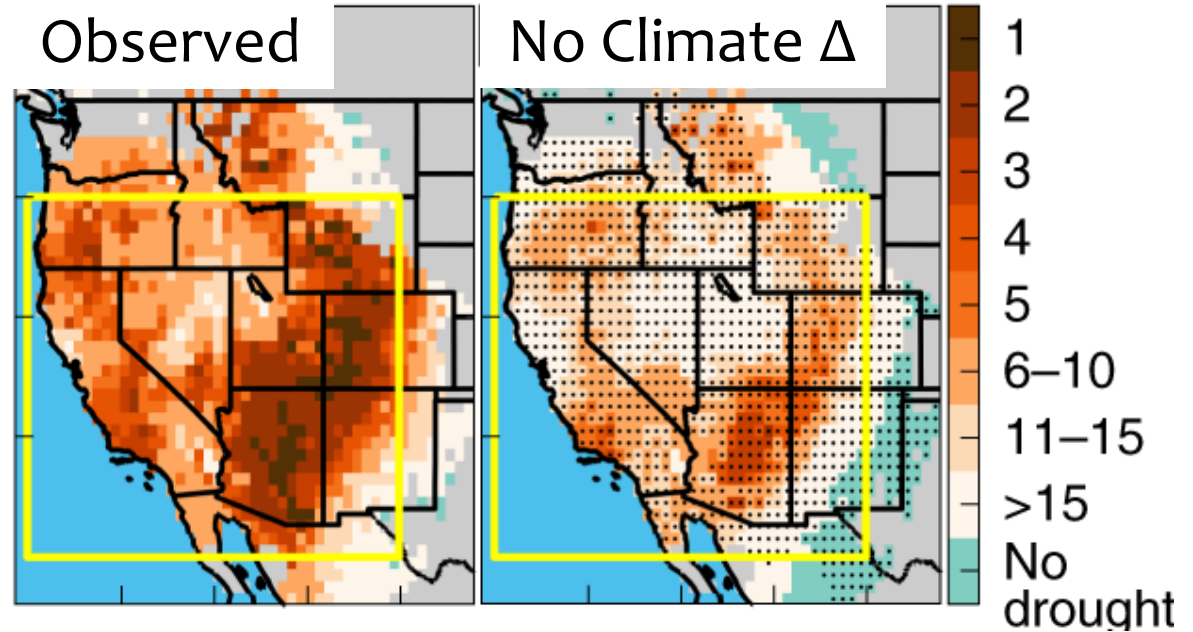


Without Warming Trend

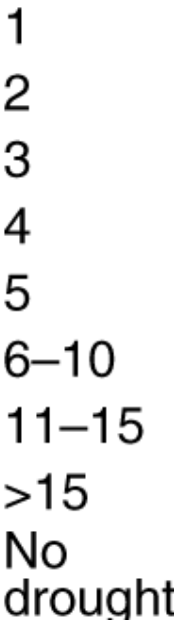
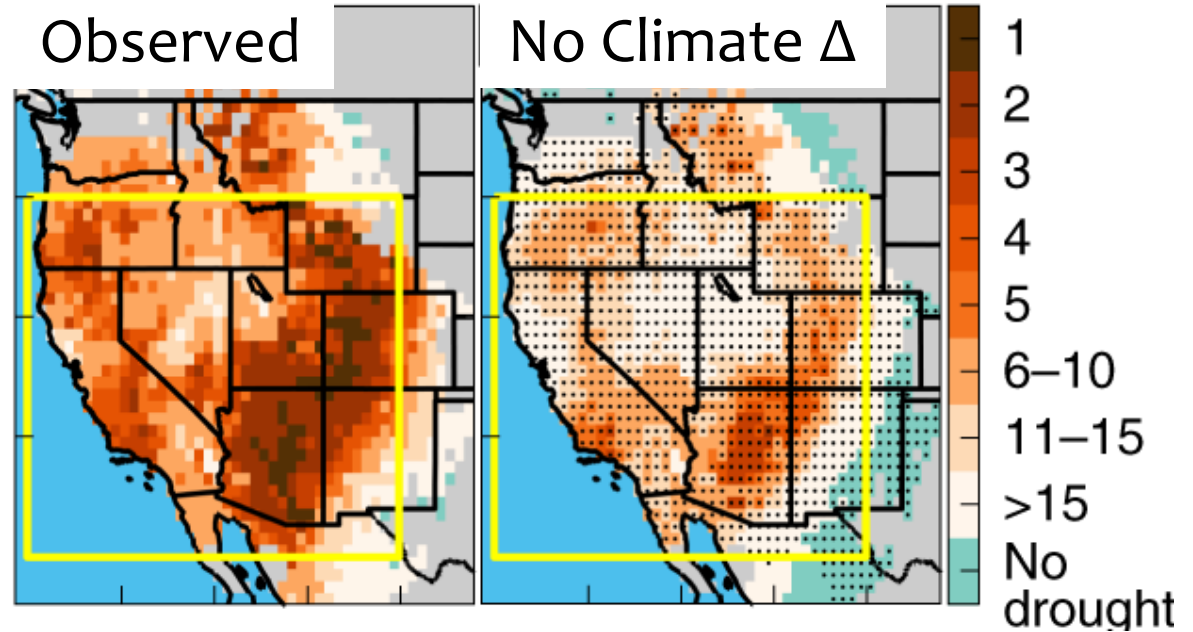


2000-2021 drought rank

Observed



No Climate  $\Delta$



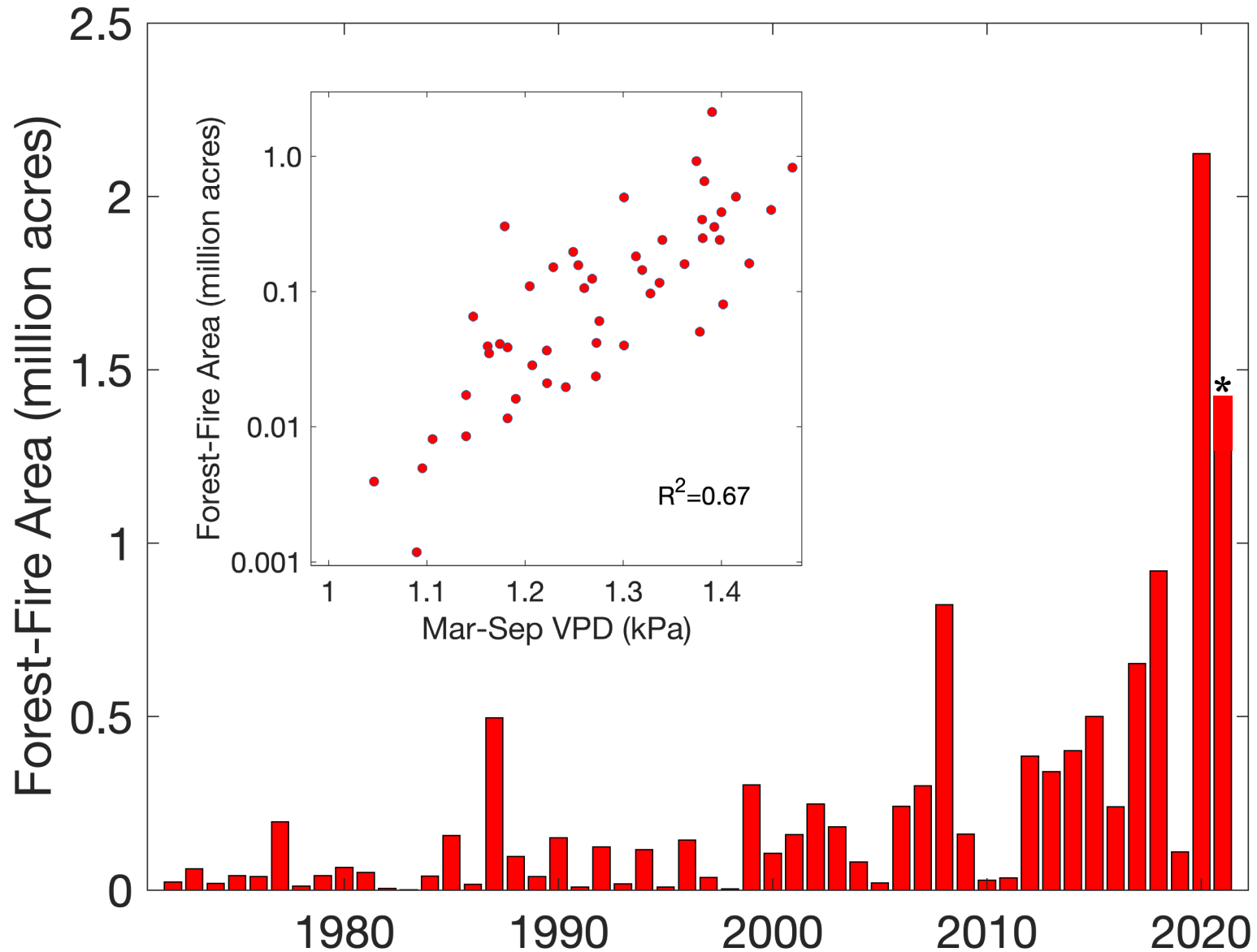
Williams et al., 2015

Williams et al., 2022

Increased evaporative demand  $\sim 2''$  per year during current drought

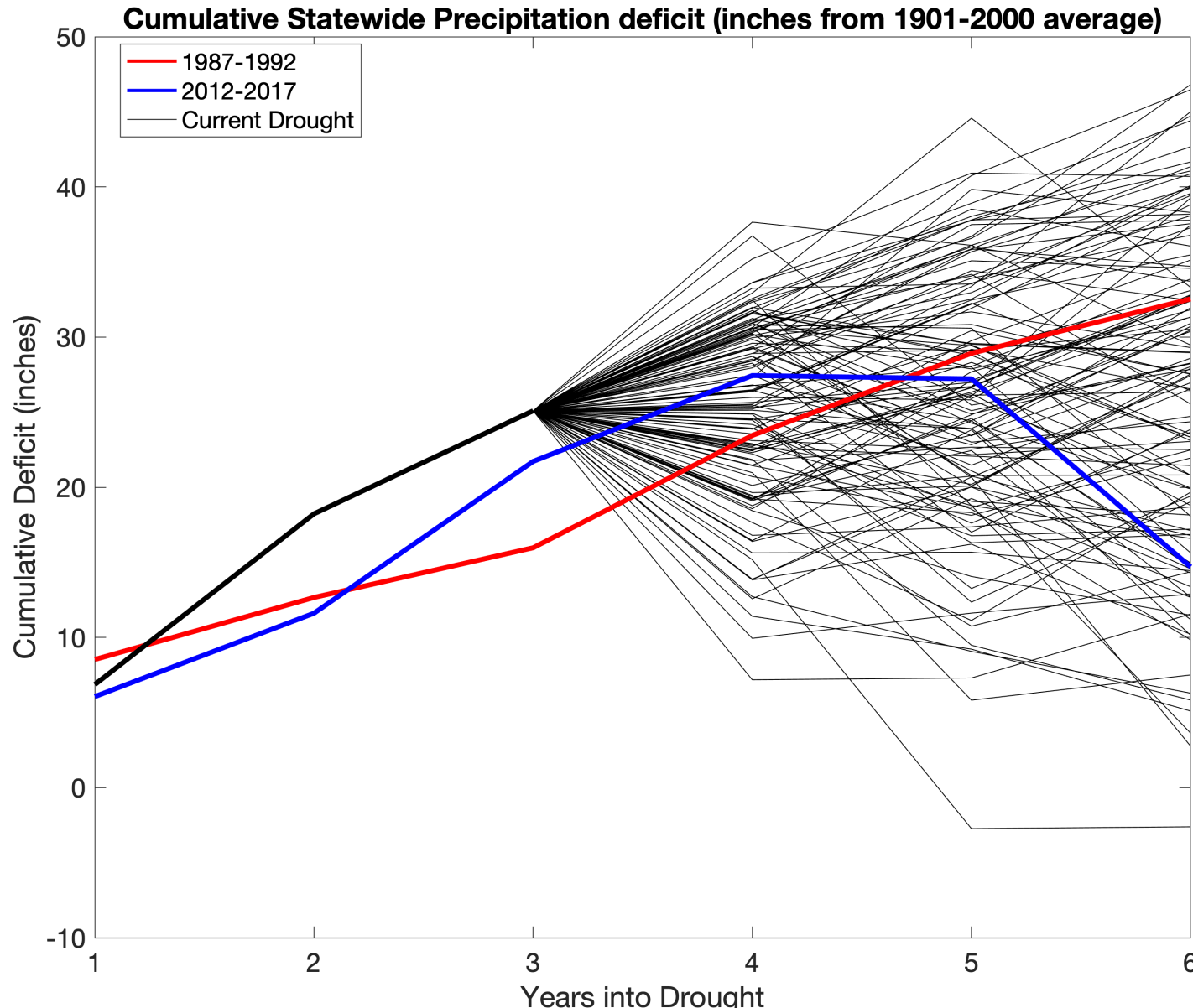
**\*\* 1 million acre feet of extra water demand for irrigated cropland alone \*\***

# Drought enables fire in California's forests



\*prelim data

# Prospects for longer-duration drought



- 30% odd of 6-yr precipitation deficit exceeding 87-92' drought
- Warmer climate with higher demand further increases odds of drought persistence

# Running Dry?

- Extreme drought has been a staple of California for the past decade
- Ongoing drought exceeds past droughts based on some measures
- Climate change is increasing the odds for extreme summer drought and *particularly multi-year droughts*