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Delta Watershed Climate and Expected Change

NASEM CVP Meeting , January 31, 2024

Michael L. Anderson, State Climatologist

Talk Overview

- Key Climate Features in the Region
- Recent Events – Extremes in Water and Fire
- Climate Change Narrative

Building the Water Year

- Fall (October/November)
  - Precipitation Onset
  - Temperature Anomaly
  - Soil Moisture State with Snowpack Initiation
- Winter (December/January/February)
  - Wet/Dry
  - Notable Anomalies
- Spring (March/April/May)
  - Late-Season Bailout or Early Shutoff?
  - Peak Snowpack Timing and Magnitude
- Summer (June/July/August/September)
  - Drying Pace and Scale
  - Heat Events
  - Tropical Activity
- Multi-Year Prediction – What about next year?

Climate Change: How much different will the next decade be?

Some Relevant California Geography

- 95% of Sacramento Basin below 7500 feet
- 50% of San Joaquin Basin above 7500 feet
- Golden Gate is 1 mile wide
- Climatological Peak Atmospheric River Activity Dec/Jan

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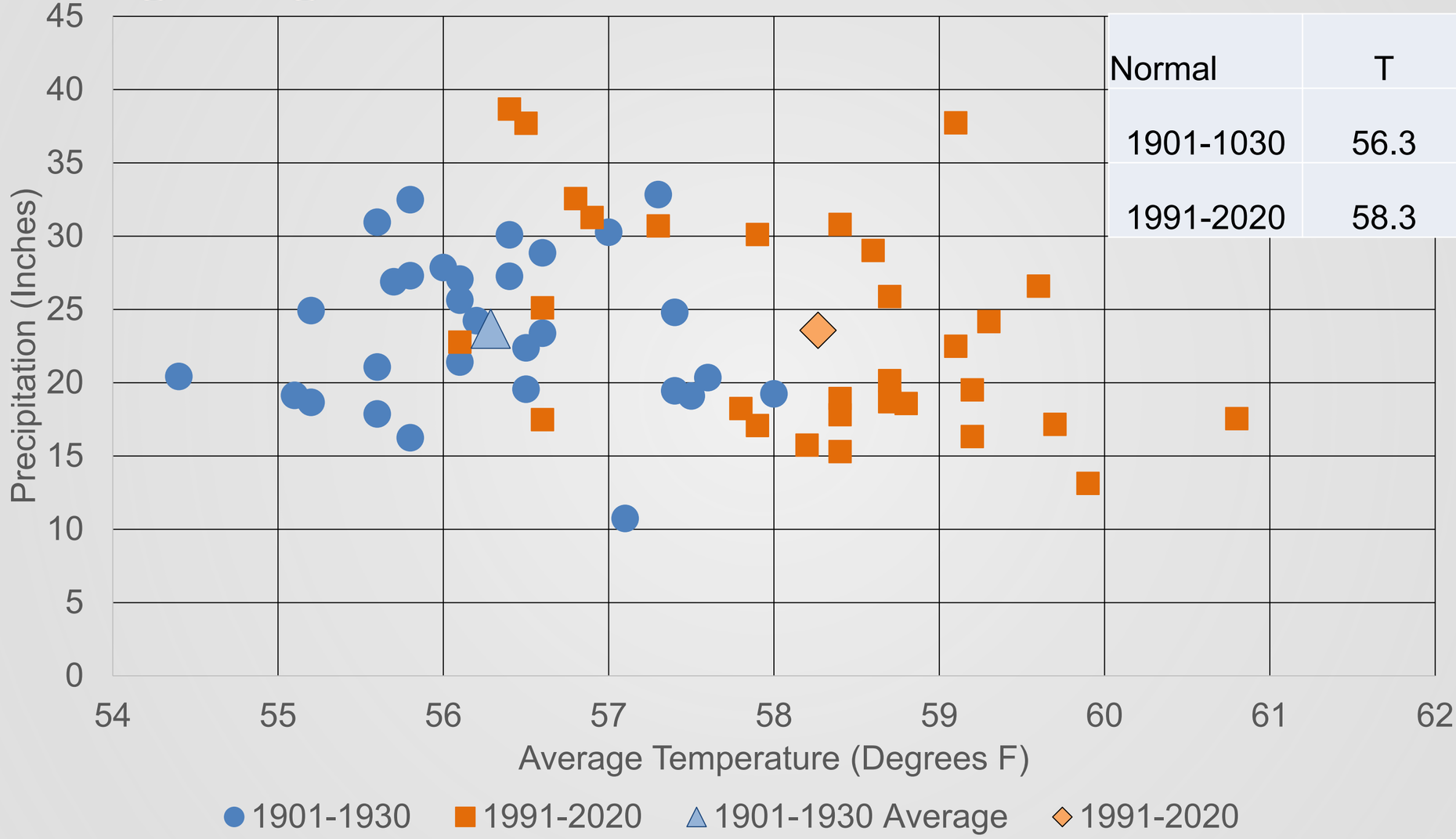
Changing Normals – 30 Year Averages



Normal	T	P
1901-1030	56.3	23.7
1991-2020	58.3	23.6

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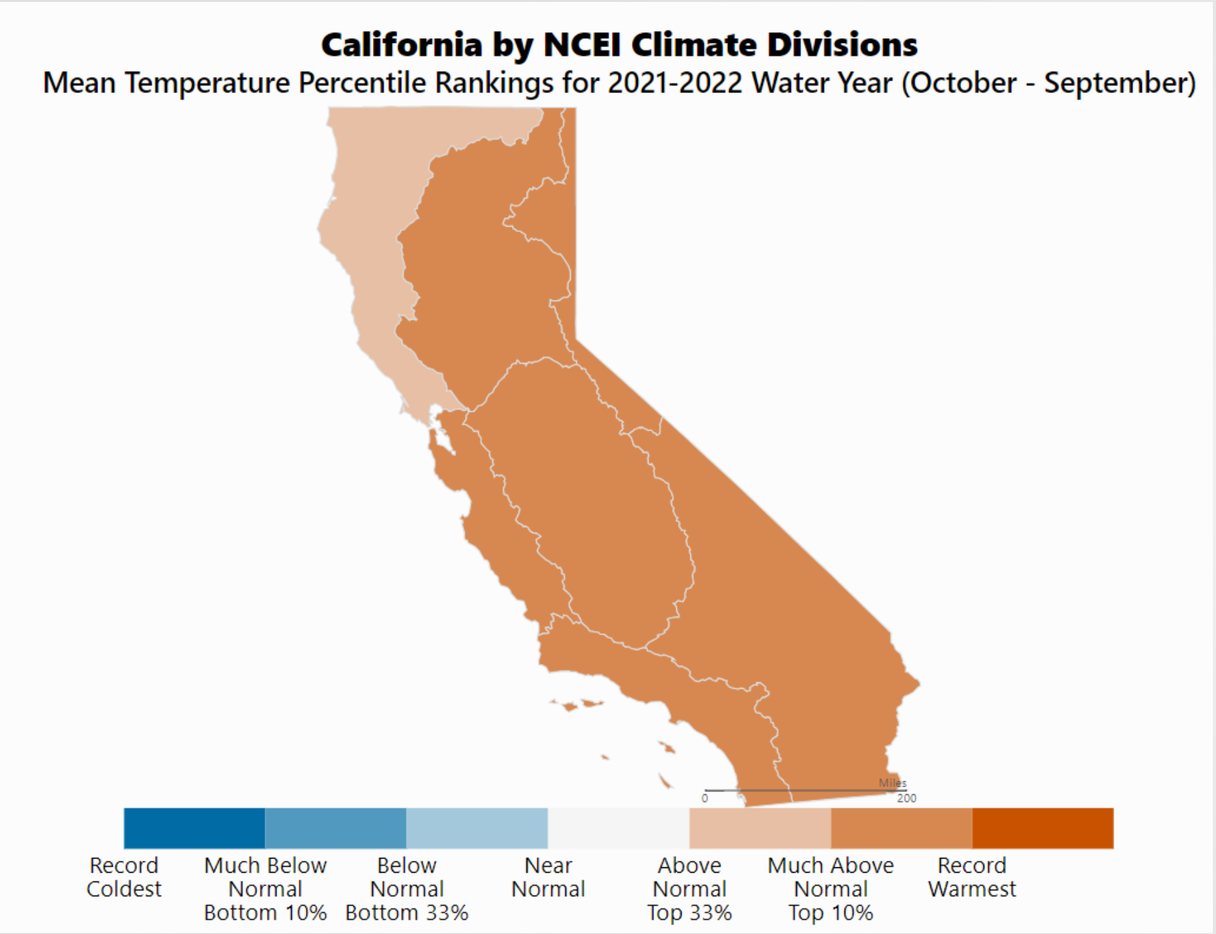
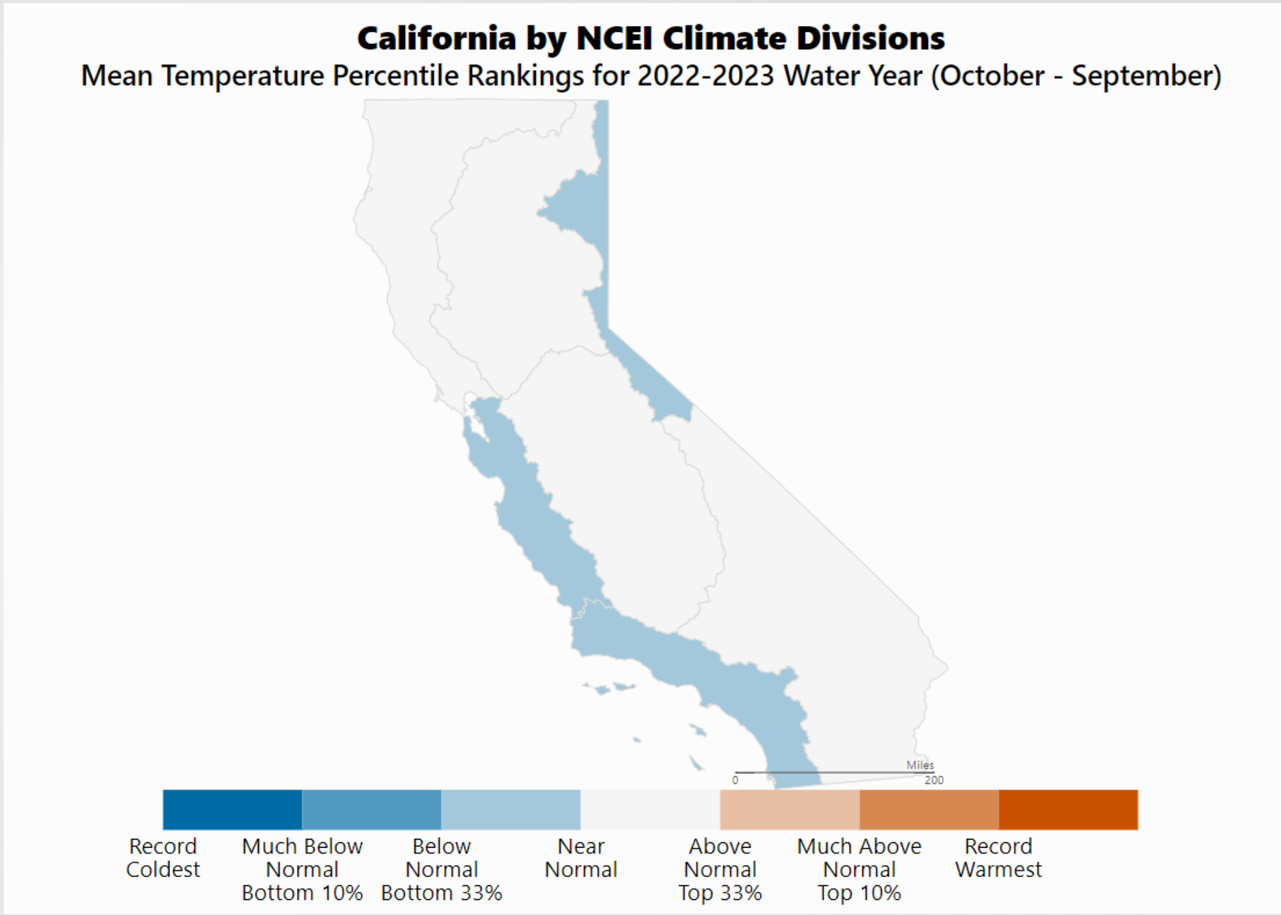
WY2022 Mean Temperature



WY2023 Mean Temperature



California Climate Tracker – Western Region Climate Center

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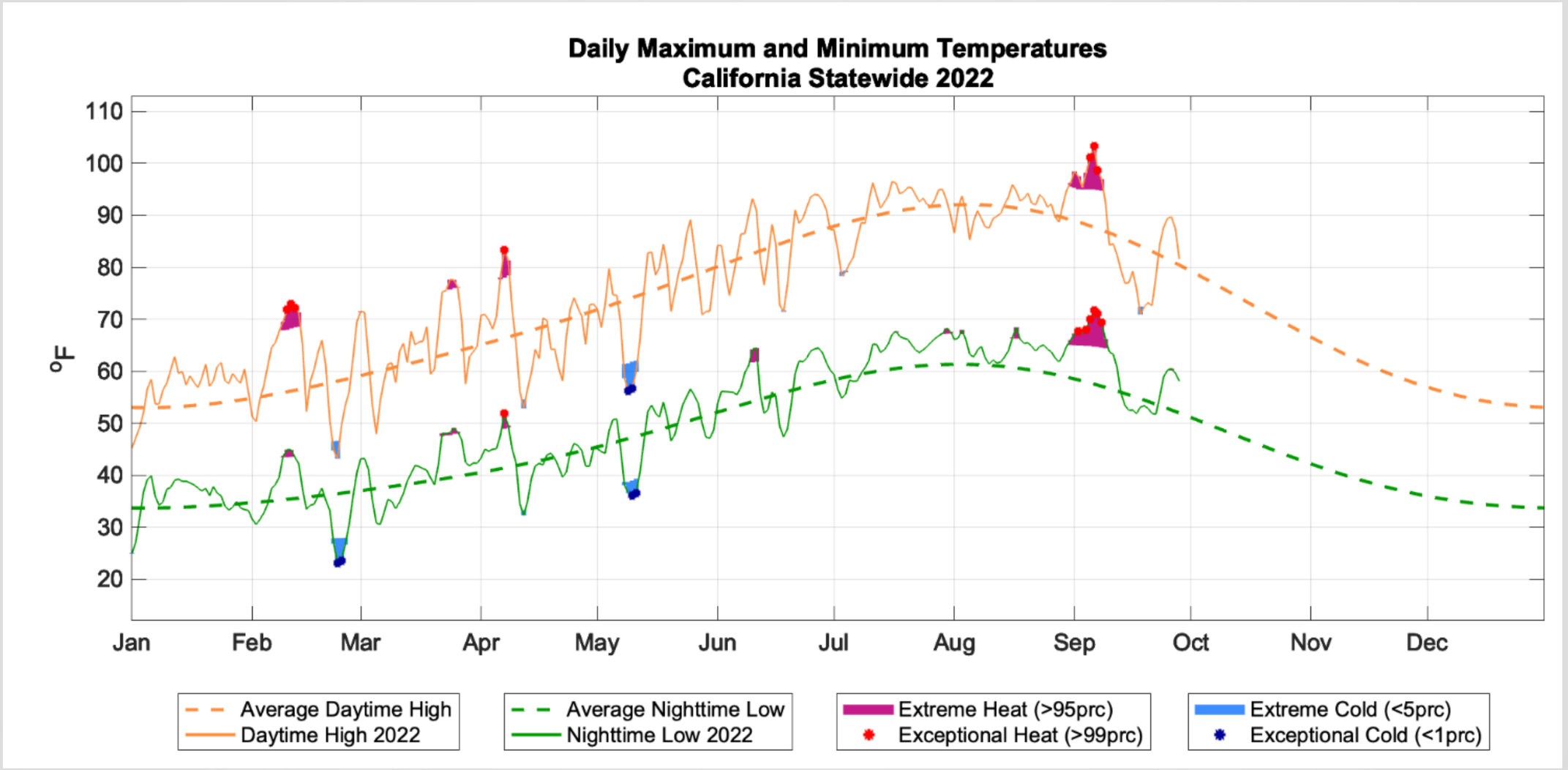
Temperature Extremes Water Year 2022



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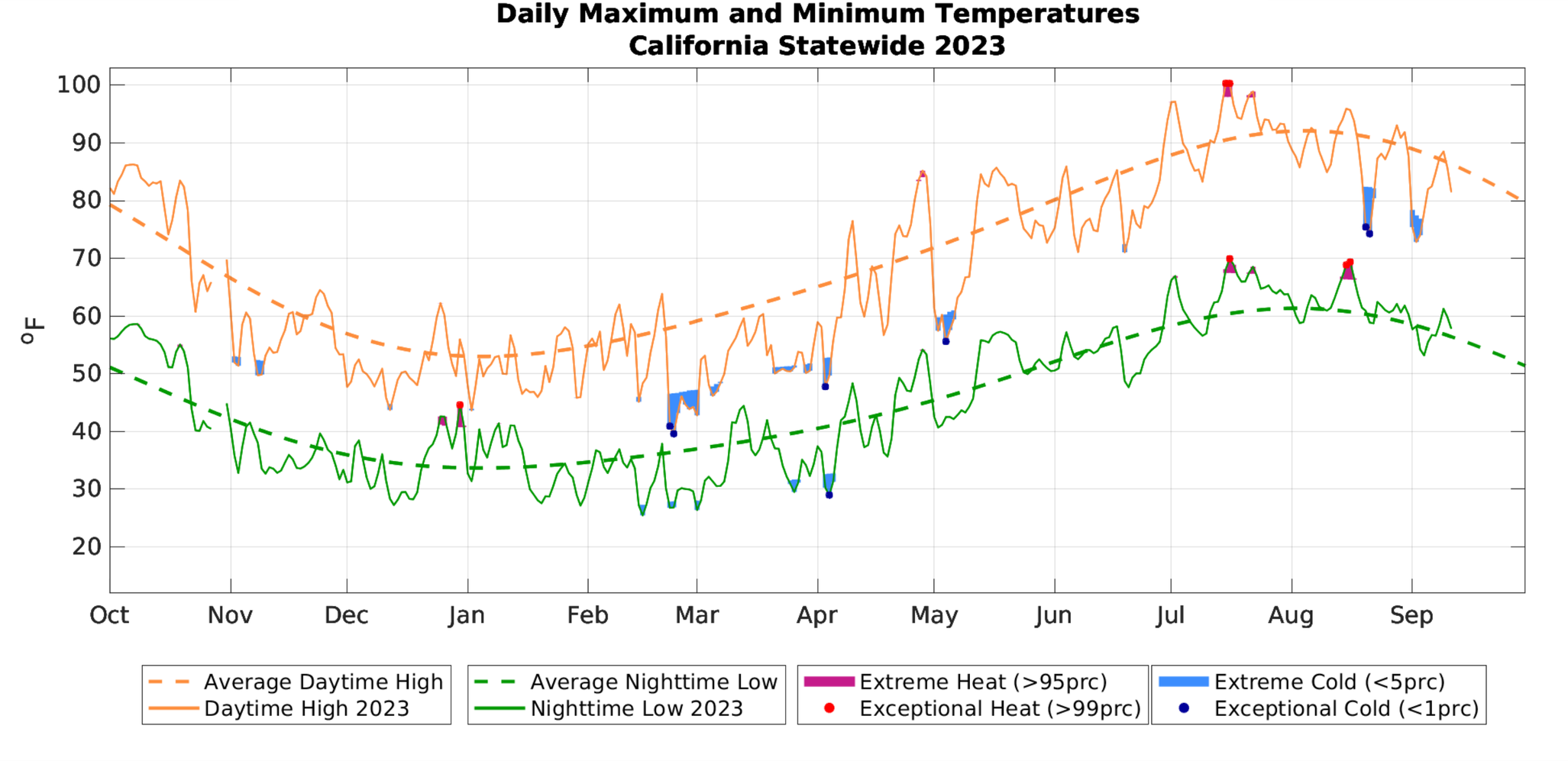
Credit: Kristen Guirguis, Scripps Institution of Oceanography

Temperature Extremes Water Year 2023



Credit: Kristen Guirguis, Scripps Institution of Oceanography

[California Heat Waves – Water Year View | Weather Extremes and Climate Impacts Analytics (ucsd.edu)]

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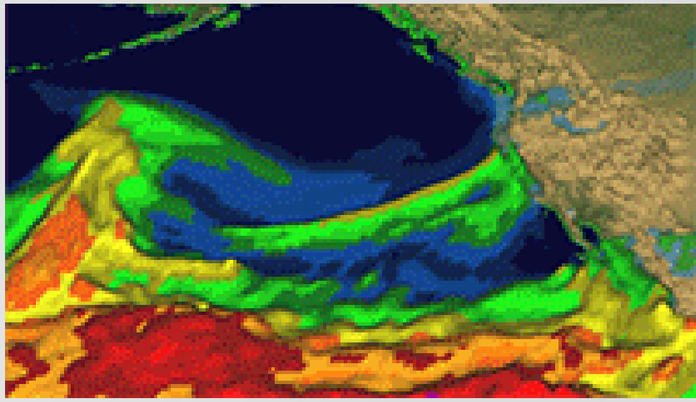
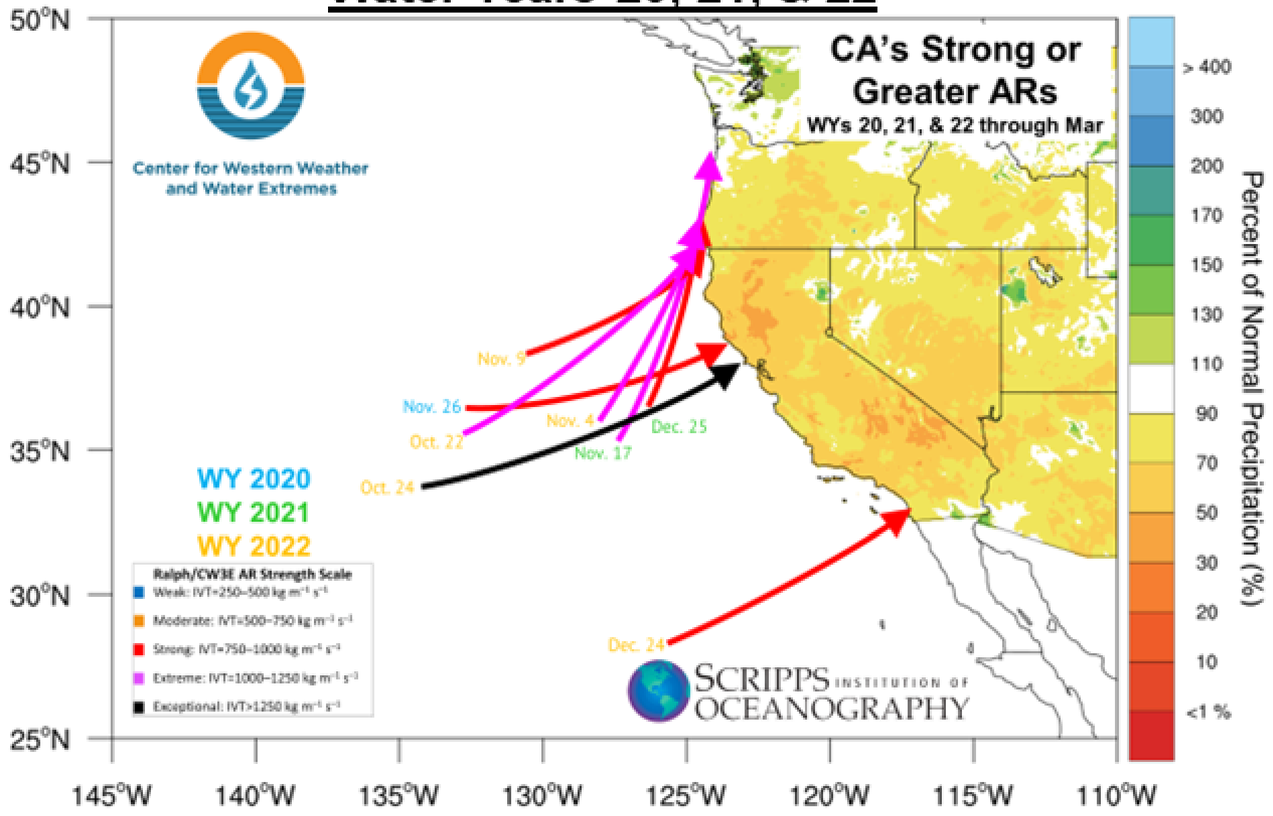
Atmospheric Rivers (AR) Background



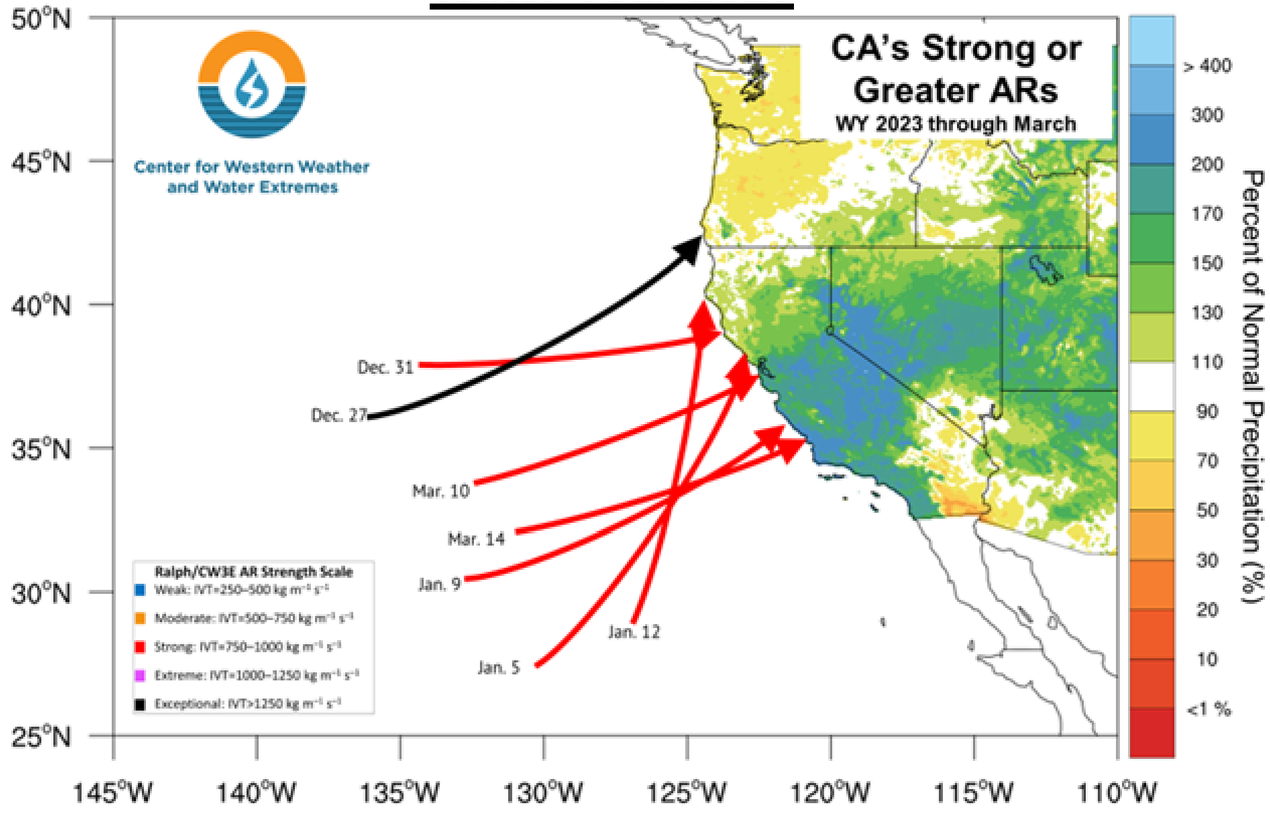
- Key moisture transport – 90% of the transport in 10% of the area; most in the first 2.5 km of atmosphere
- Important for both water supply and flooding – 40-60% of annual precipitation; associated with more than 90% of flood damages in northern CA

Strong+ Magnitude ARs can Make the Difference

Water Years 20, 21, & 22



Water Year 2023



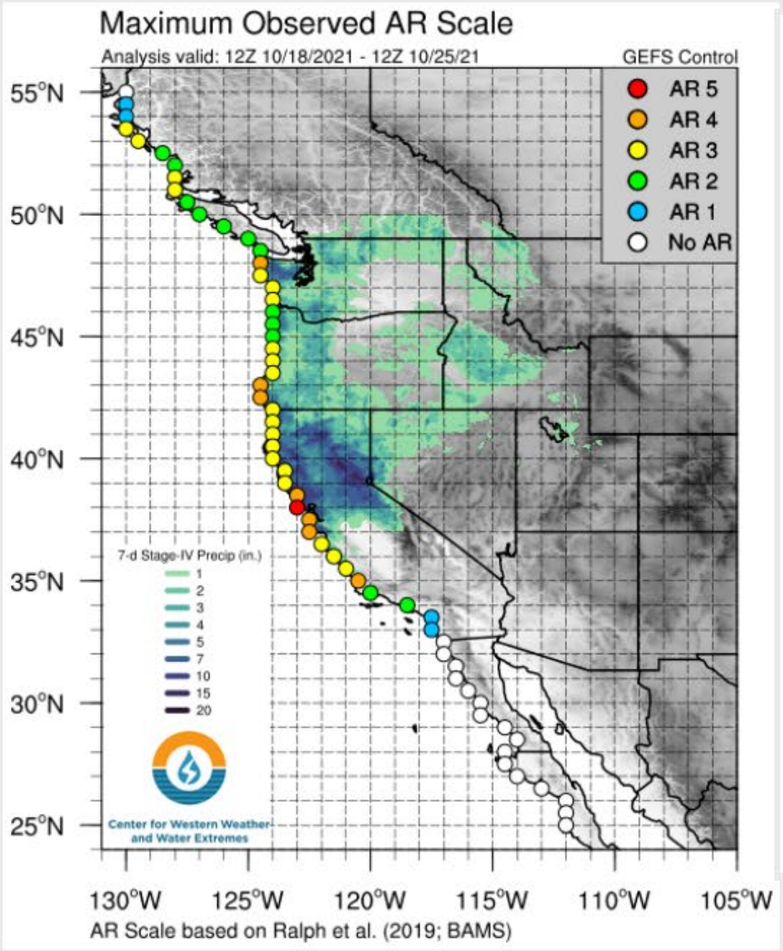
- California experienced **eight** instances of strong or greater magnitude AR conditions during Water Years 2020, 2021, & 2023, resulting in a multi-year drought (California averages six strong or greater magnitude ARs per water year)
- In water year 2023, California experienced **seven** instances of strong or greater magnitude AR conditions, nearly equaling the total from the previous three water years and resulting in >200% of normal water year precipitation across central California from the Coast to the Sierra and the Intermountain West
- **Note:** Several of the strong ARs in WYs 20, 21 & 22 were strongest over PNW indicating weakening, but still strong, ARs over CA

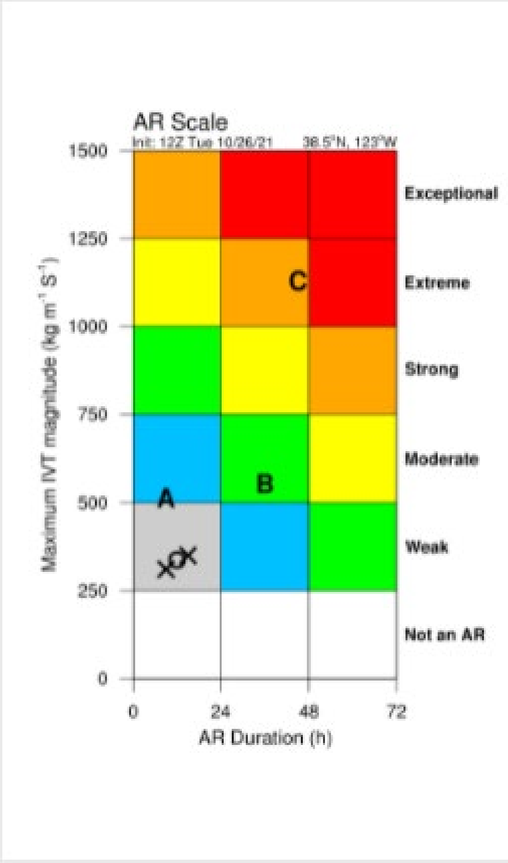
*Arrows are placed on the map where each AR was strongest over the coast

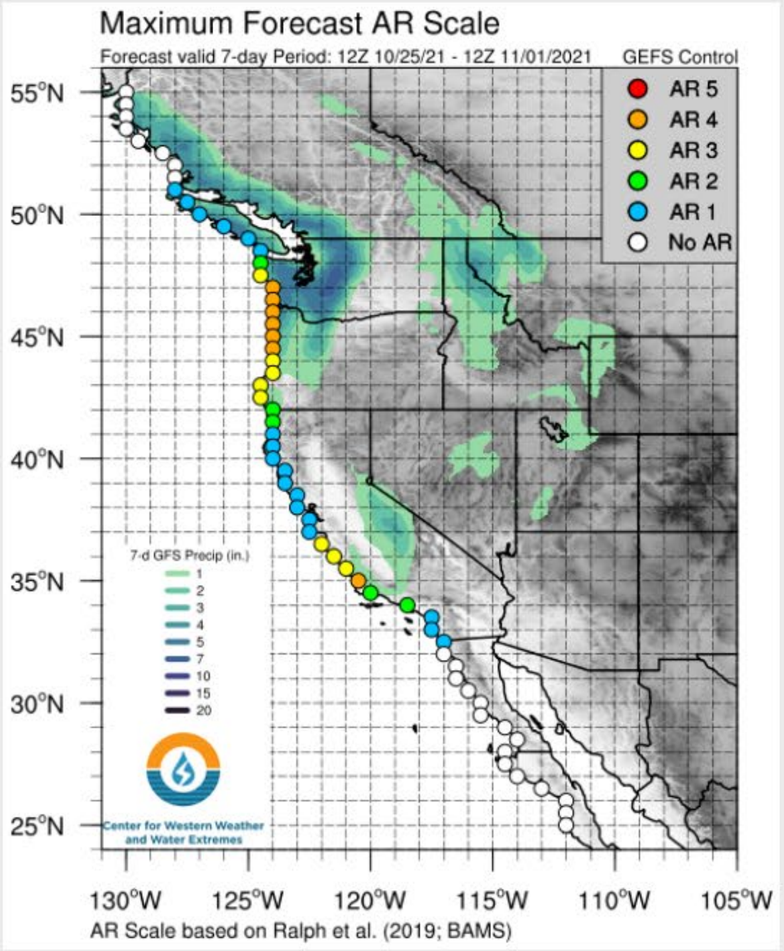
Atmospheric River Scale

Show Precipitation: On **Model:** U.S. National Model (GEFS) **Locations:** Coastal

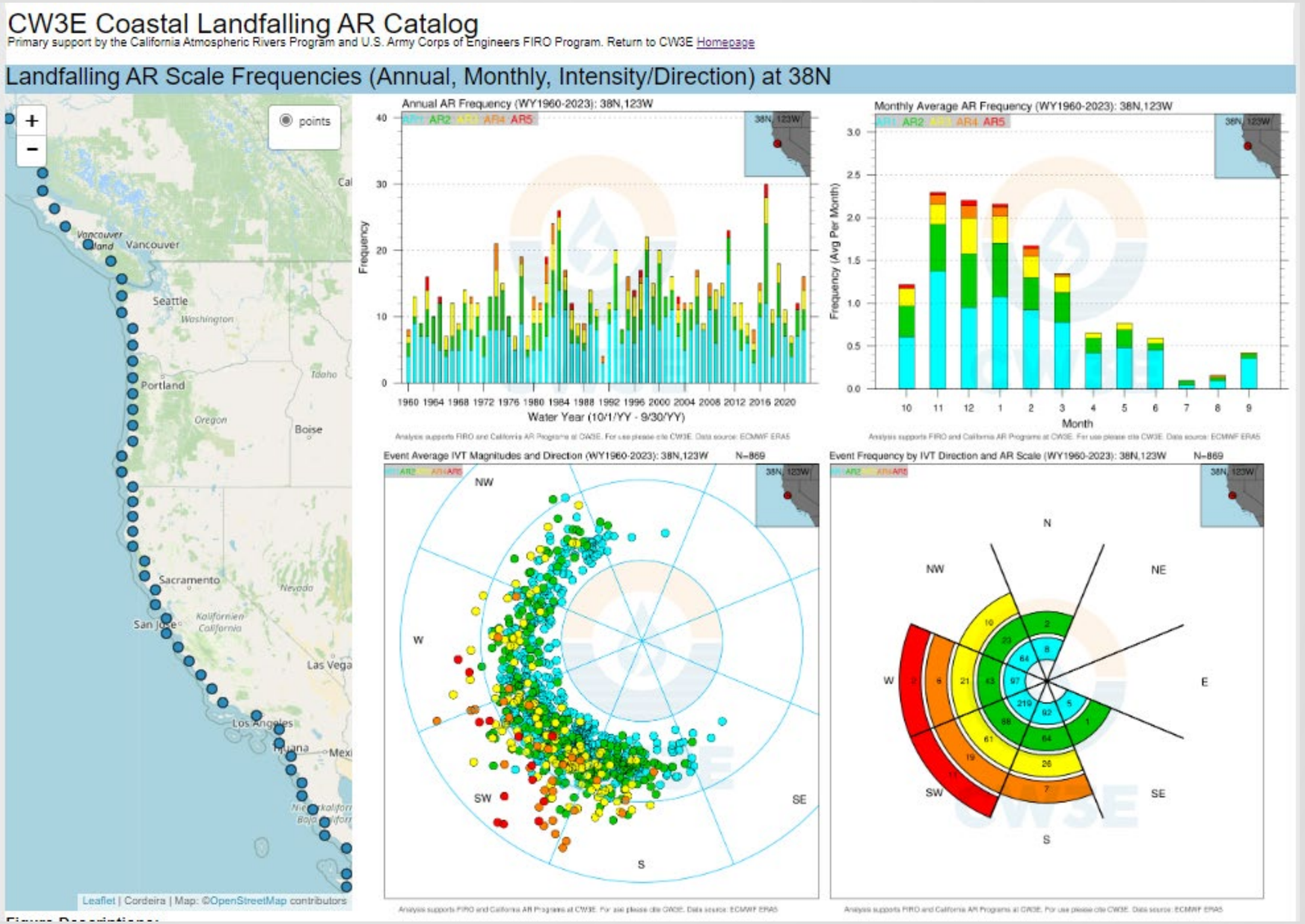
Past 7 days (observed) **Future 7 days (forecast):** Control Forecast







CW3E – Atmospheric River Landfall Catalog



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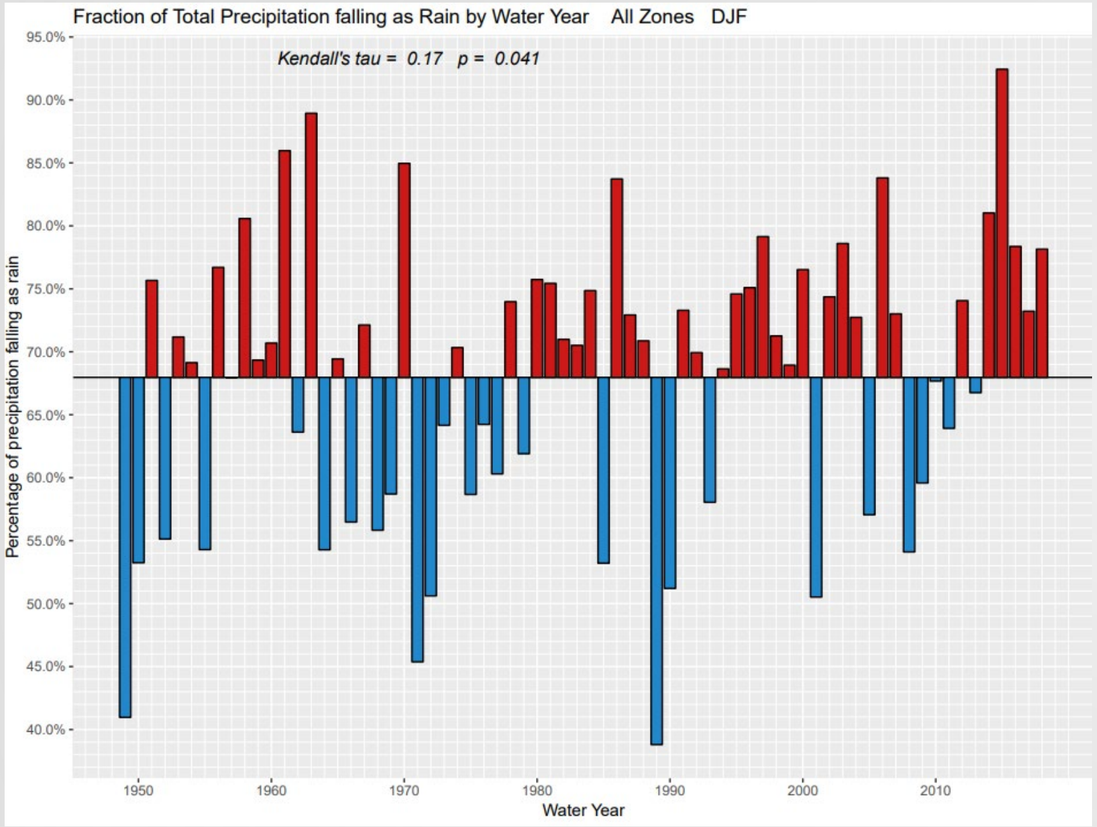
Rain or Snow?



- The rain/snow boundary is complex
- Seasonally signs of change are beginning to show
- Each watershed is different

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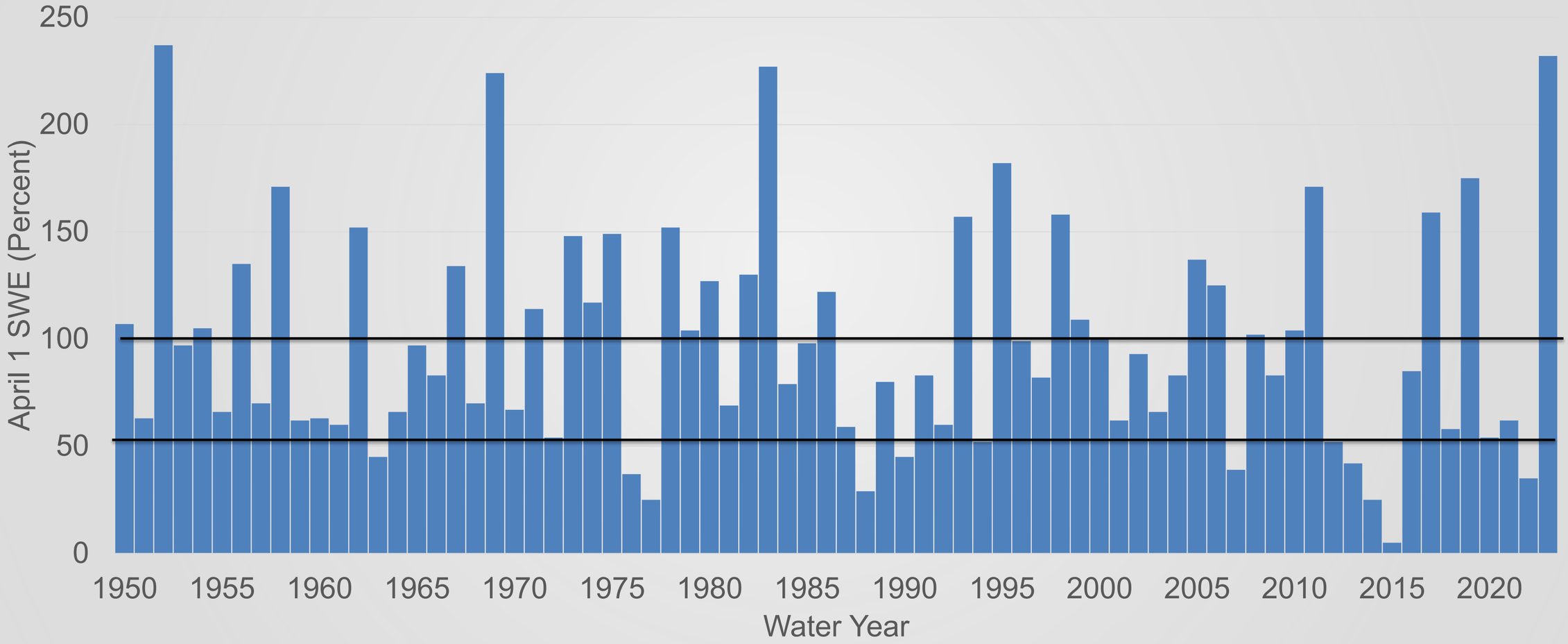
April 1 Statewide Snow Water Equivalent



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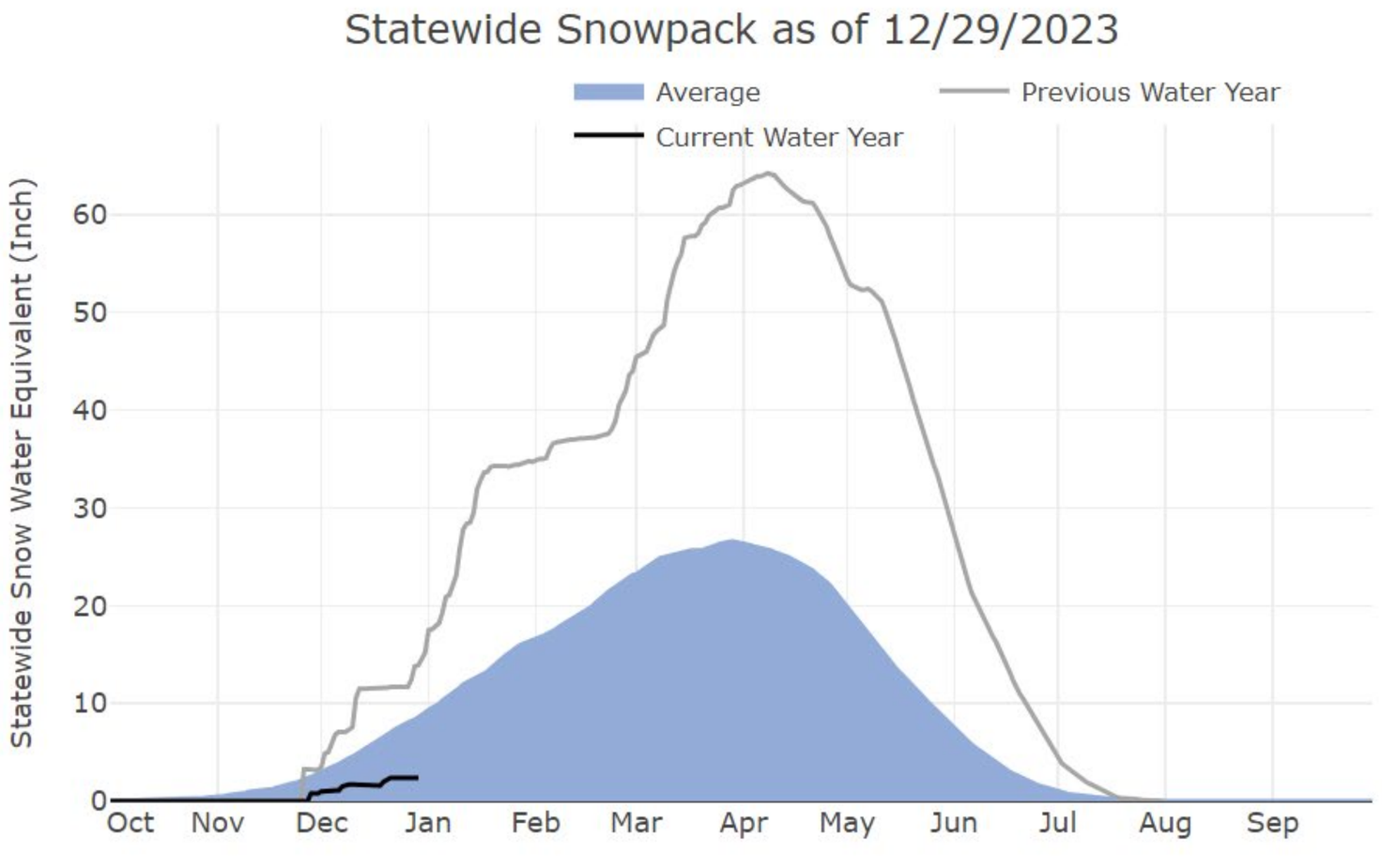
The Statewide Snowpack for 2023



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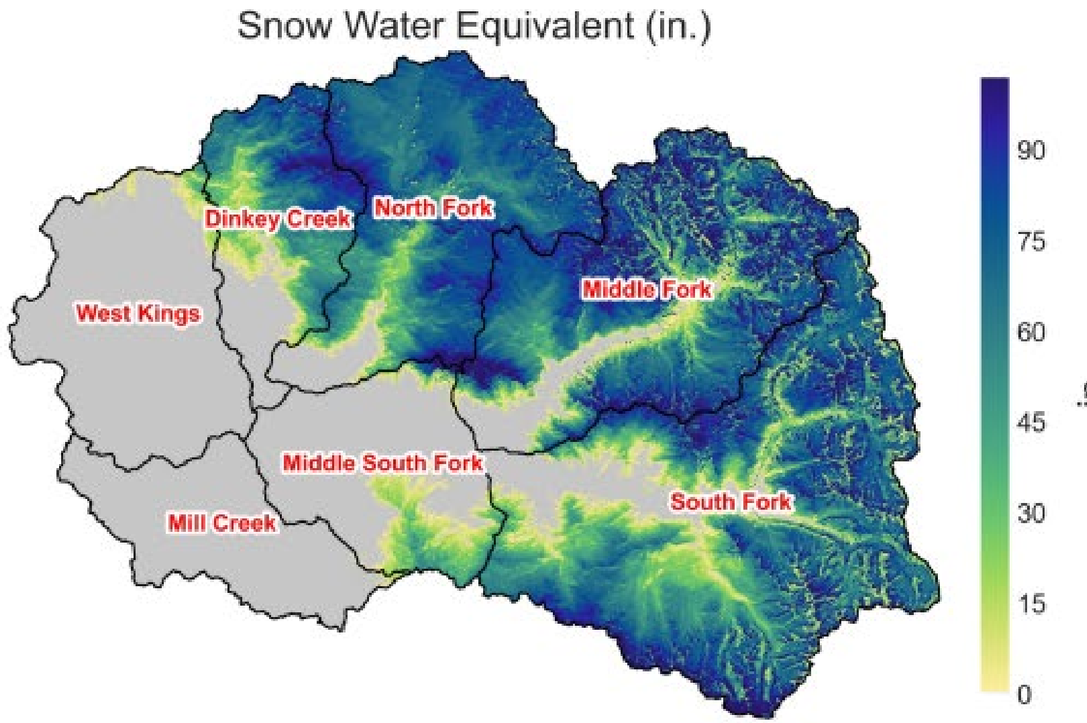
https://snow.water.ca.gov

Key Snowpack Information



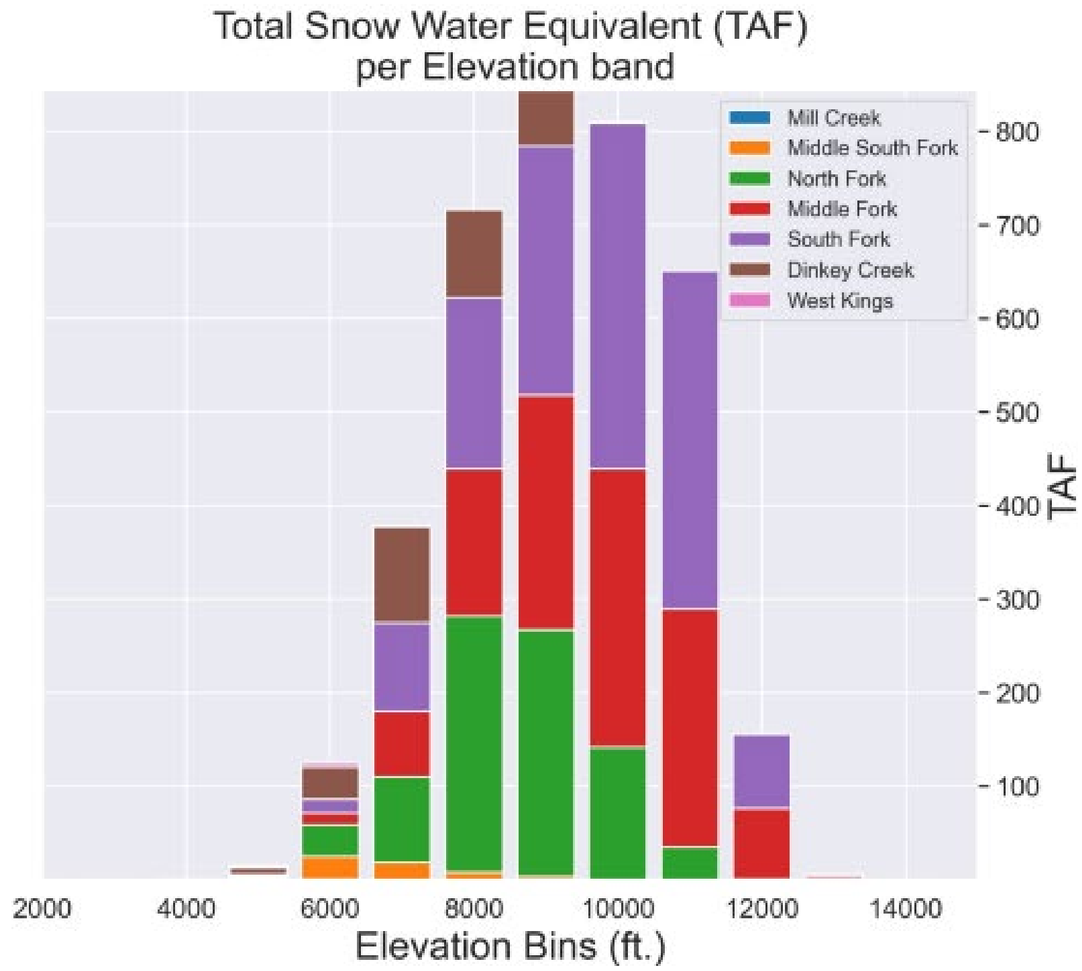


Fig.5 Snow Water Equivalent as of 2023-04-22

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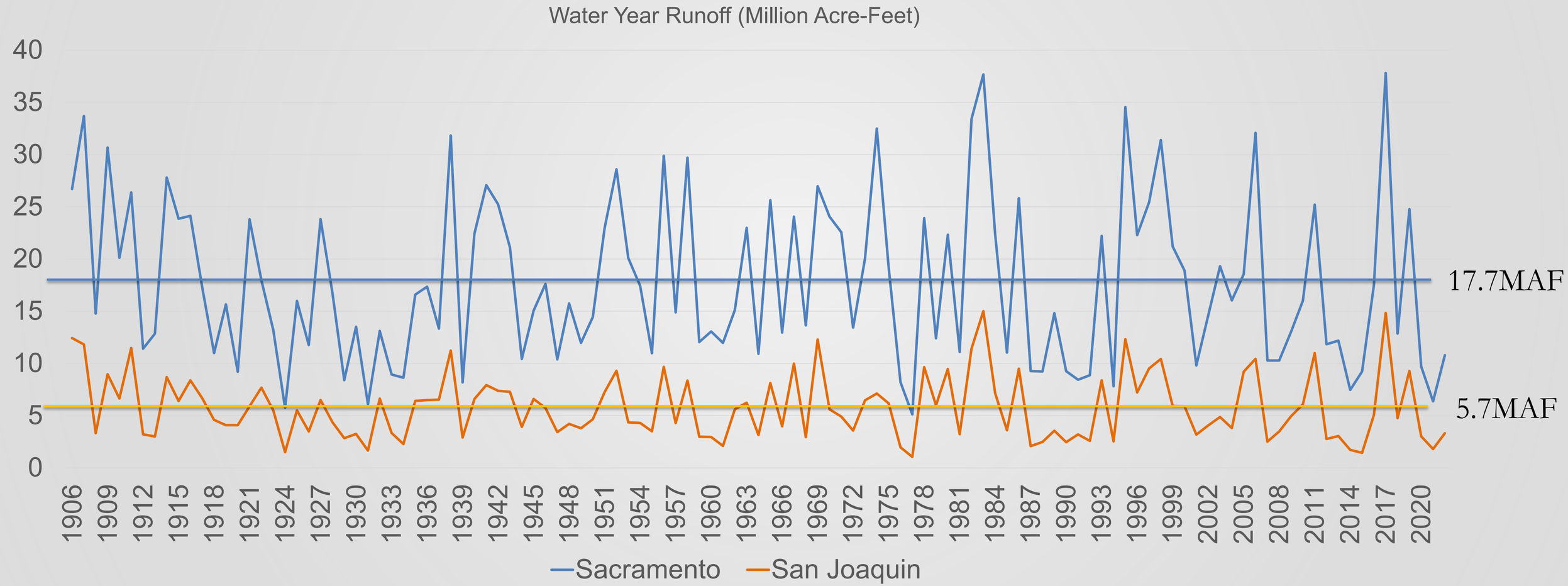
Runoff Magnitude Sacramento and San Joaquin Rivers (1906-2022)



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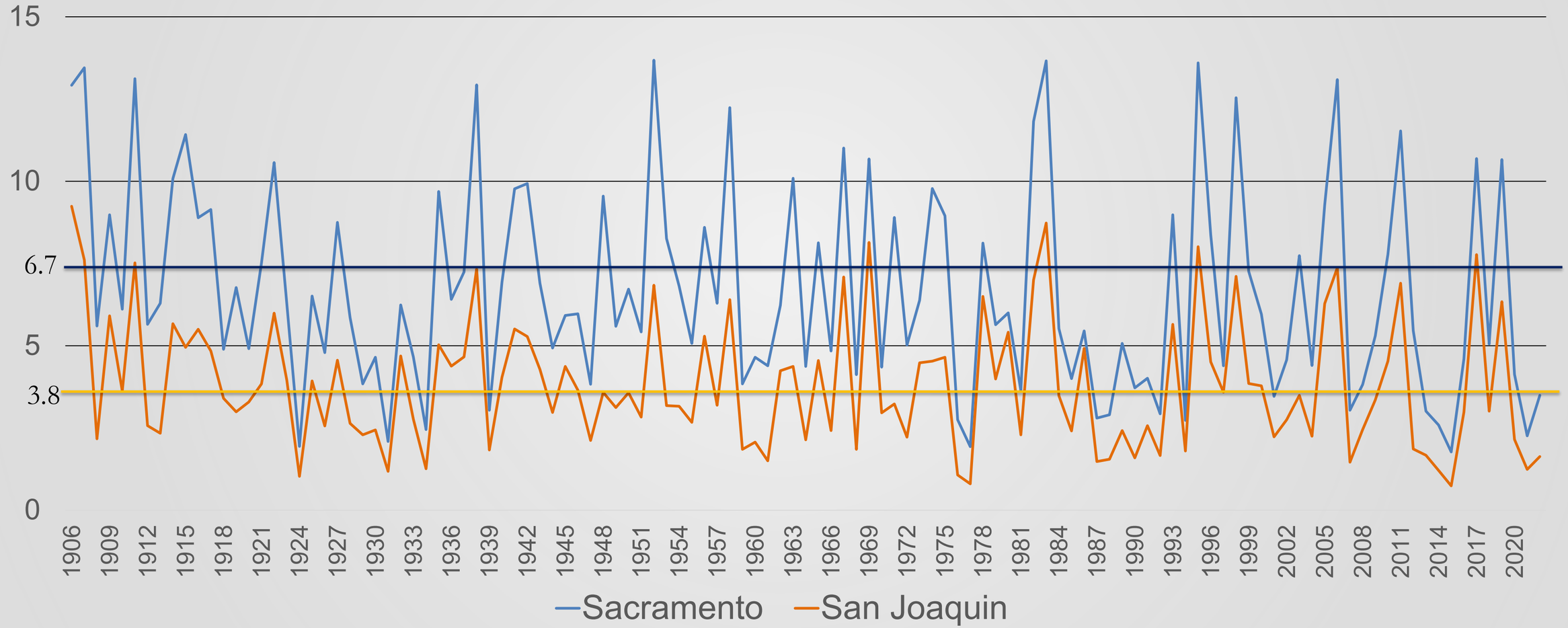
Snowmelt (April-July) Runoff (Million Acre-Feet)



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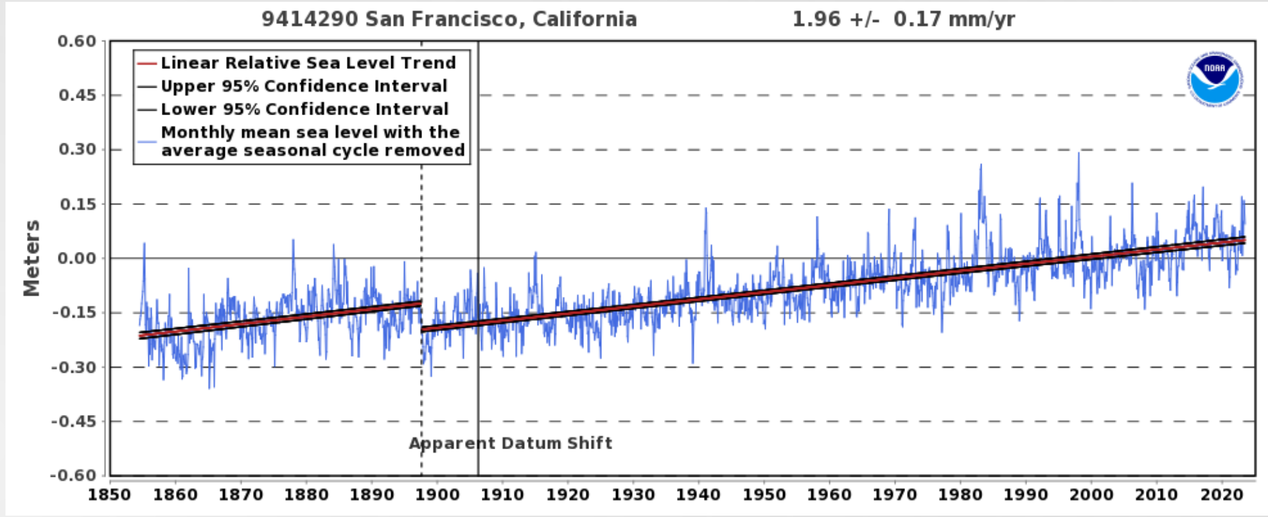
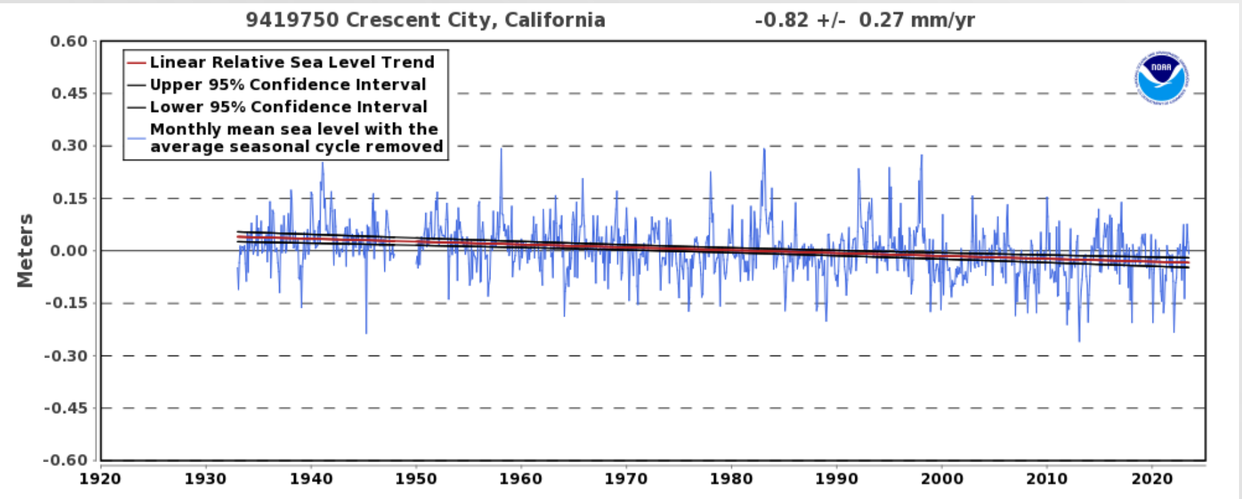
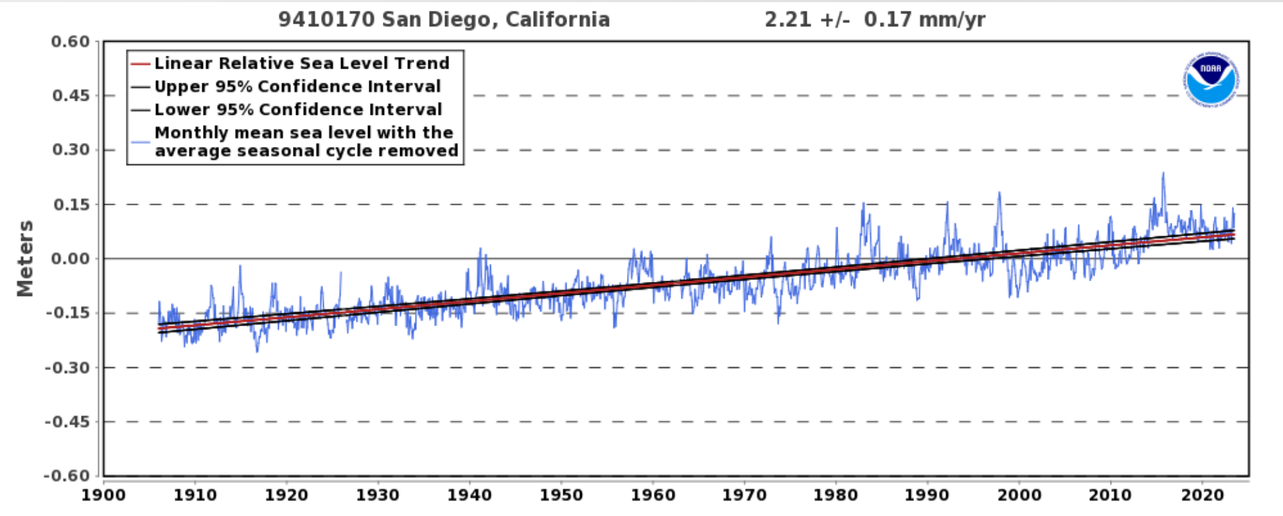
Sea Level Rise (SLR)

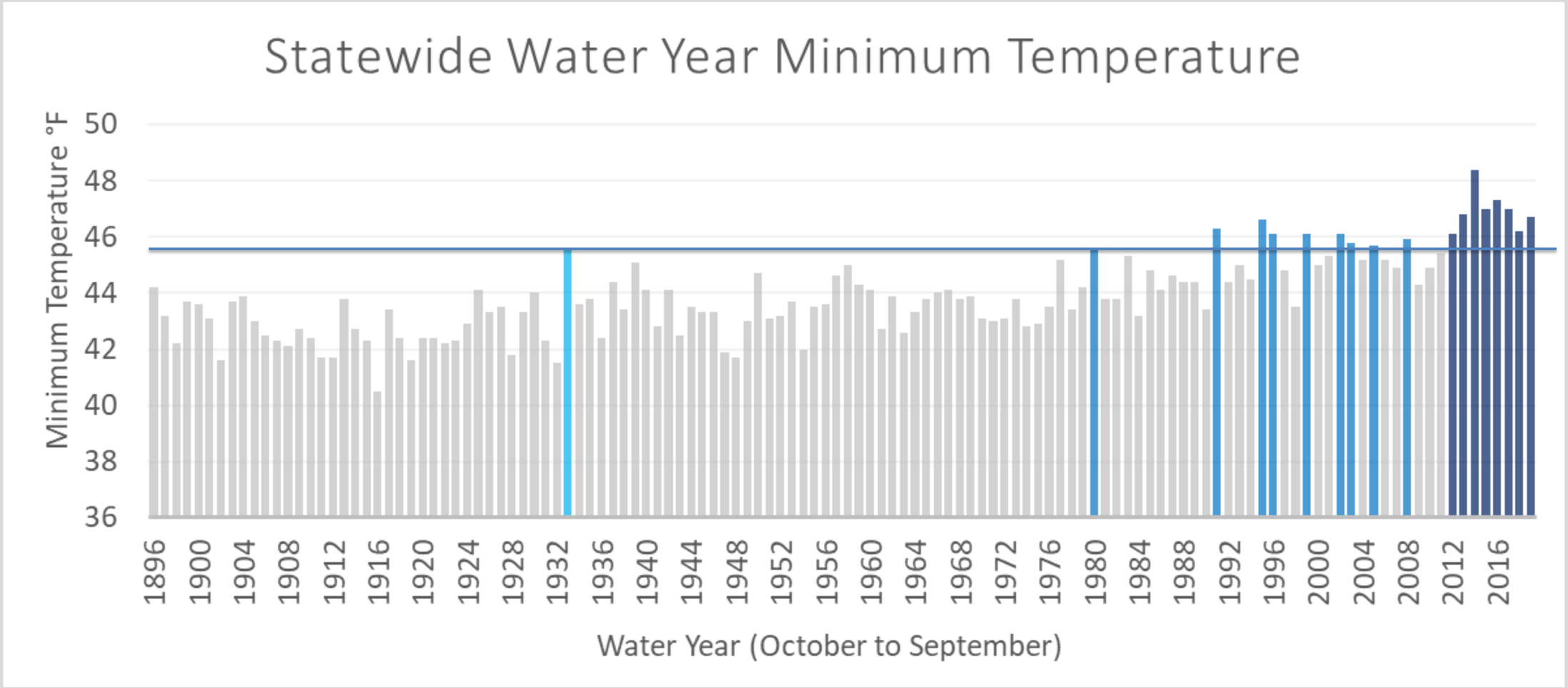
- Temperature and Volume Effects
- Land Surface Subsidence/ Uplift Considerations
- Intra-annual and Interannual Variability







From Extreme to Common



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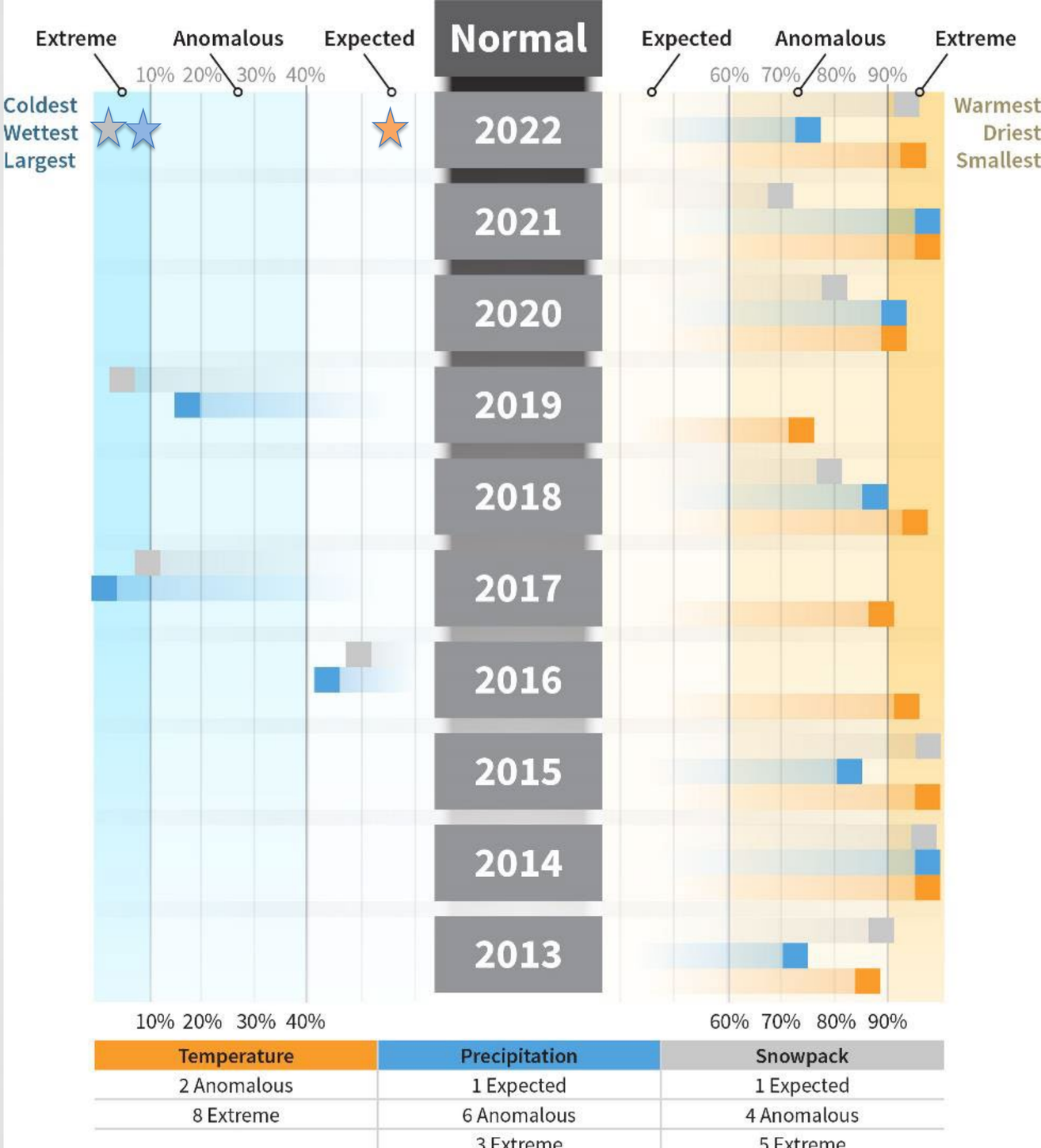
A Decade of Extremes

- WY2023 adding to extremes narrative
  - Dry to Wet shift
  - Multiple Extremes
  - New Records
  - Coolest Year Since 2011



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Wildfires and California

Top 20 Largest California Wildfires

	FIRE NAME (CAUSE)	DATE	COUNTY	ACRES
1	**AUGUST COMPLEX** *(Lightning)*	August 2020	Mendocino, Humboldt, Trinity, Tehama, Glenn, Lake, & Colusa	**1,032,648**
2	**DIXIE** *(Powerlines)*	July 2021	Butte, Plumas, Lassen, Shasta & Tehama	**963,309**
3	**MENDOCINO COMPLEX** *(Human Related)*	July 2018	Colusa, Lake, Mendocino & Glenn	**459,123**
4	**SCU LIGHTNING COMPLEX** *(Lightning)*	August 2020	Stanislaus, Santa Clara, Alameda, Contra Costa, & San Joaquin	**396,625**
5	**CREEK** *(Undetermined)*	September 2020	Fresno & Madera	**379,895**
6	**LNU LIGHTNING COMPLEX** *(Lightning/Arson)*	August 2020	Napa, Solano, Sonoma, Yolo, Lake, & Colusa	**363,220**
7	**NORTH COMPLEX** *(Lightning)*	August 2020	Butte, Plumas & Yuba	**318,935**
8	**THOMAS** *(Powerlines)*	December 2017	Ventura & Santa Barbara	**281,893**
9	**CEDAR** *(Human Related)*	October 2003	San Diego	**273,246**
10	**RUSH** (*Lightning*)	August 2012	Lassen	**271,911 CA / 43,666 NV**

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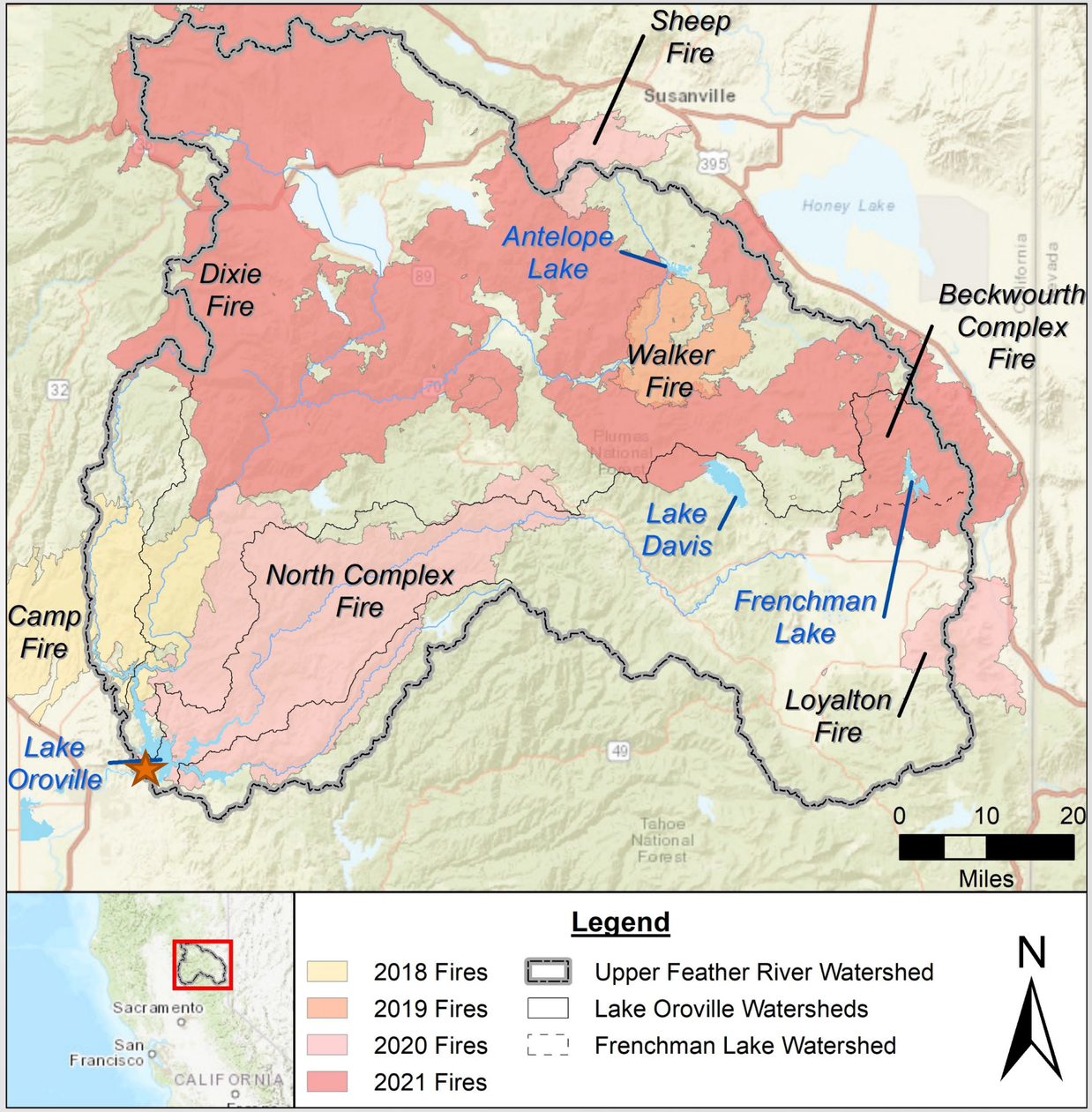
From Statistics | CAL FIRE

Fires in the Upper Feather River Watershed

- **57%** of the Upper Feather River Watershed has burned since 2018
- **27%** burned at high severity (75% tree mortality)
- The majority of shoreline around Lake Oroville has burned (largely in Camp Fire and North Complex Fire)



Watershed Area Above Lake Oroville Approx. 2.3 million acres

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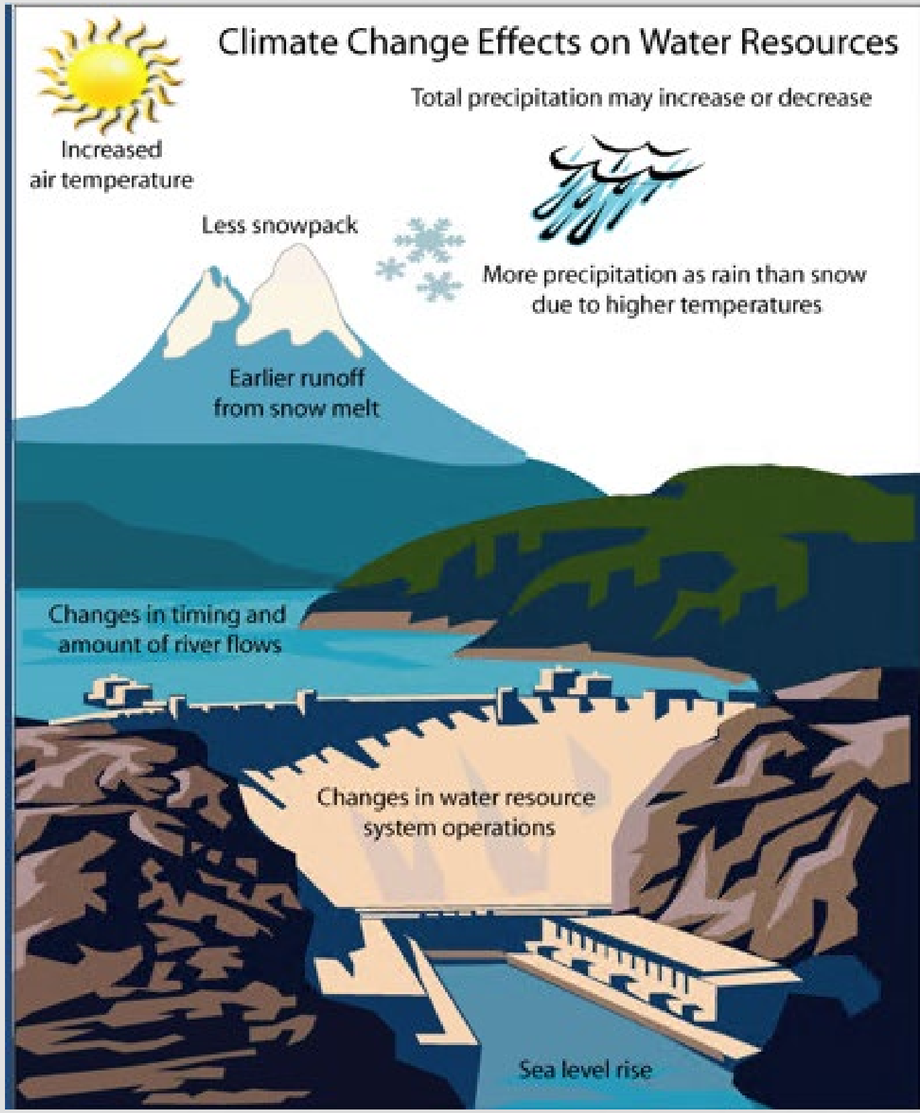
The Narrative of Climate Change in CA

- Warmer Temperatures
- Greater variability/more extremes
- More Rain Less Snow
- Longer Dry Season
- Rising Sea Levels
- Ecosystem Changes



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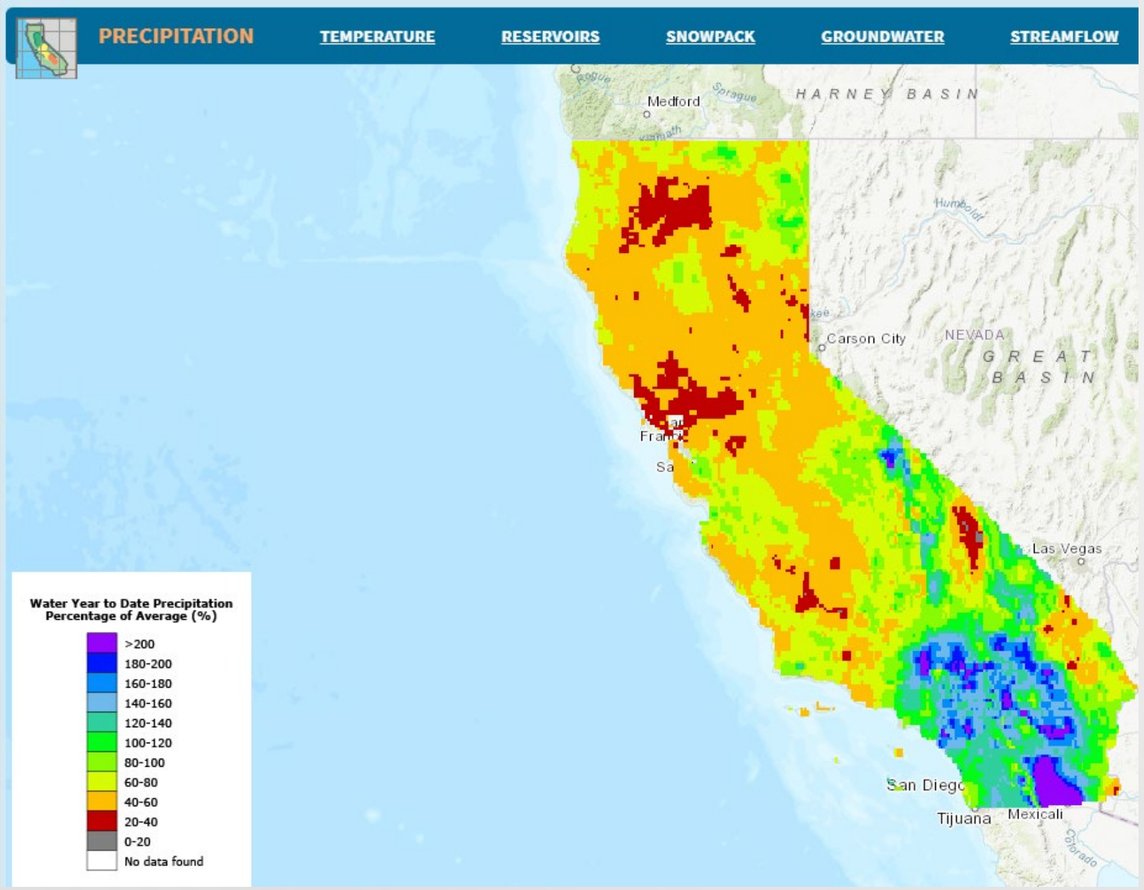
Why are warmer droughts worse?

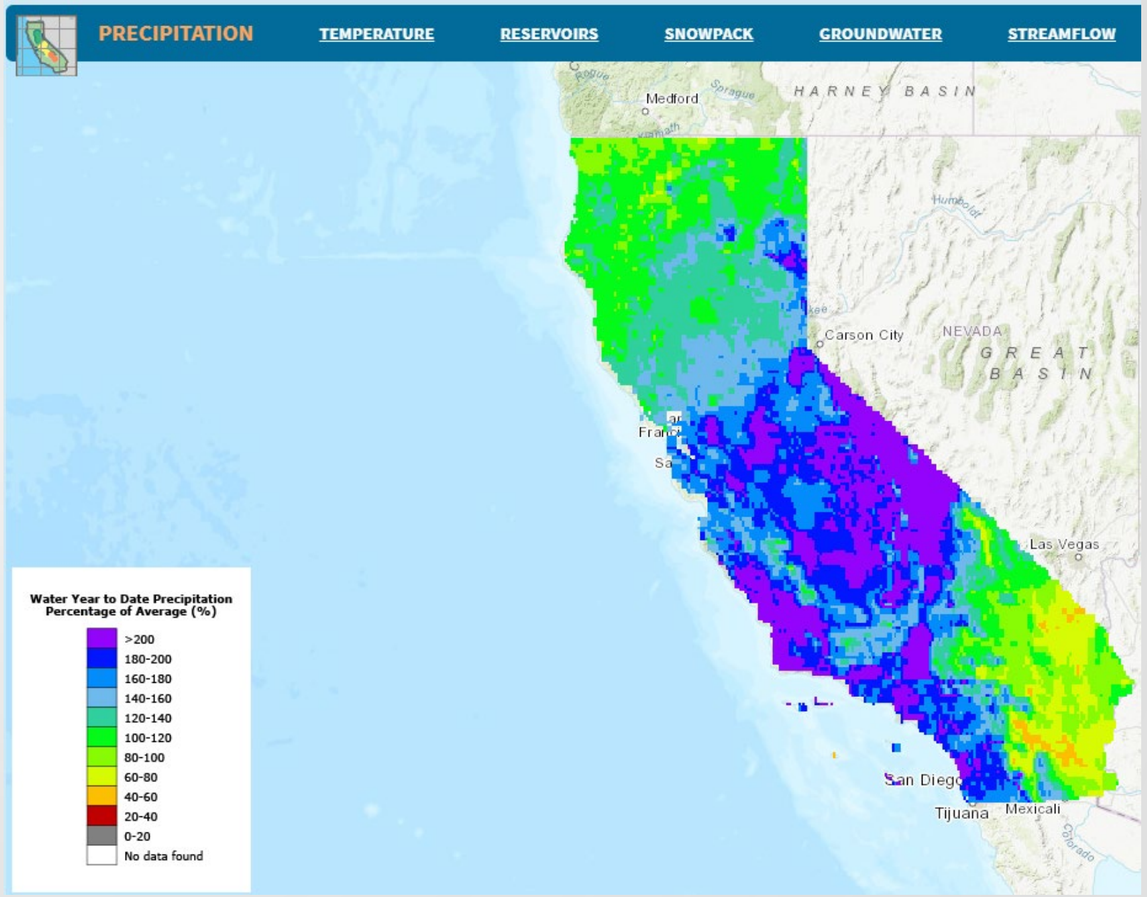
- Warmer, drier conditions dry out soils more increasing soil water deficit to be filled before runoff happens
- Warmer air can hold more water vapor increasing thirstiness of atmosphere to pull more water from landscape

Within-Year Variability Water Year 2023

December 1, 2022



April 1, 2023



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Sentinel View of Tulare Lakebed April 2023

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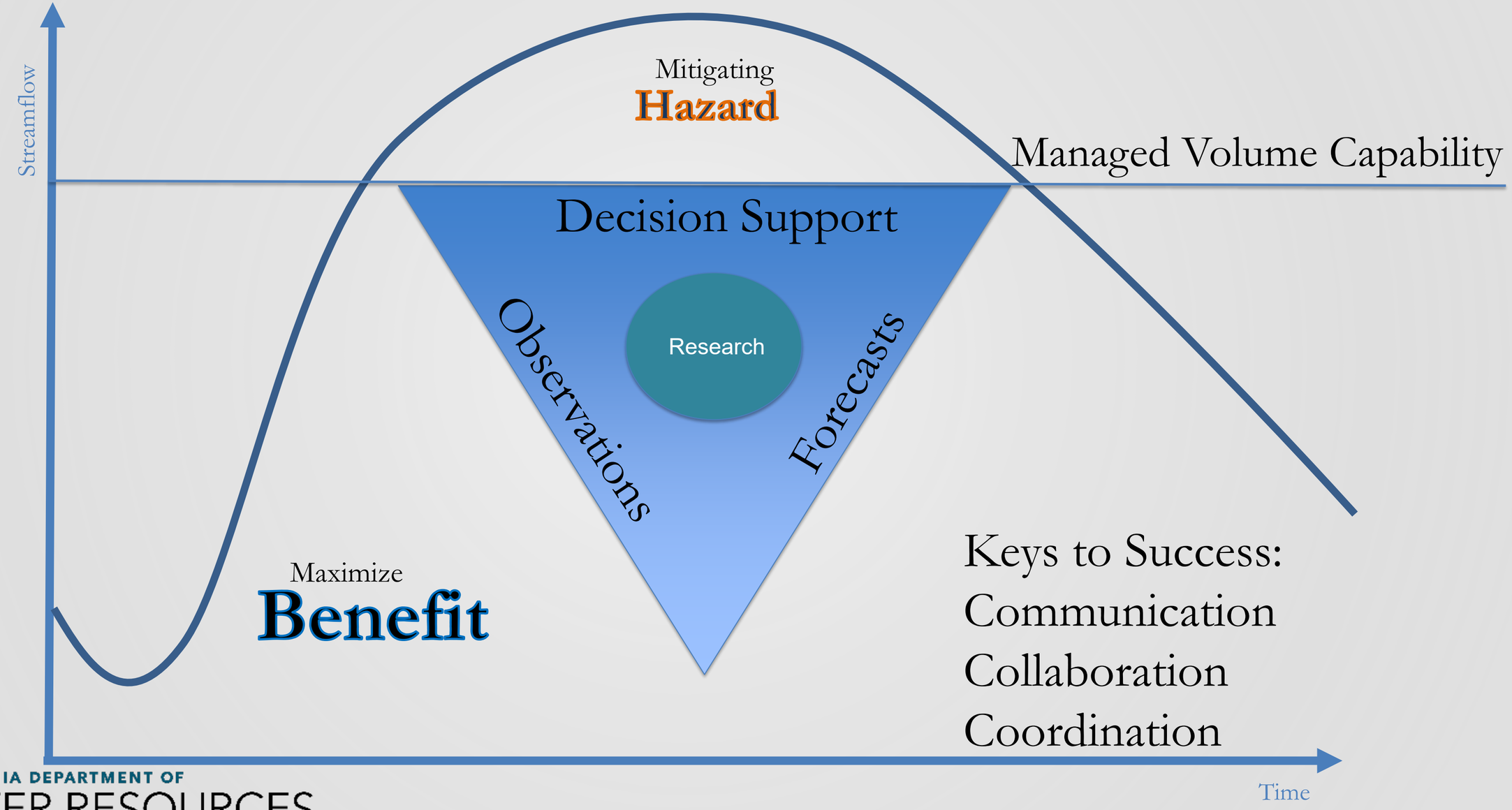
Dynamic Water Management



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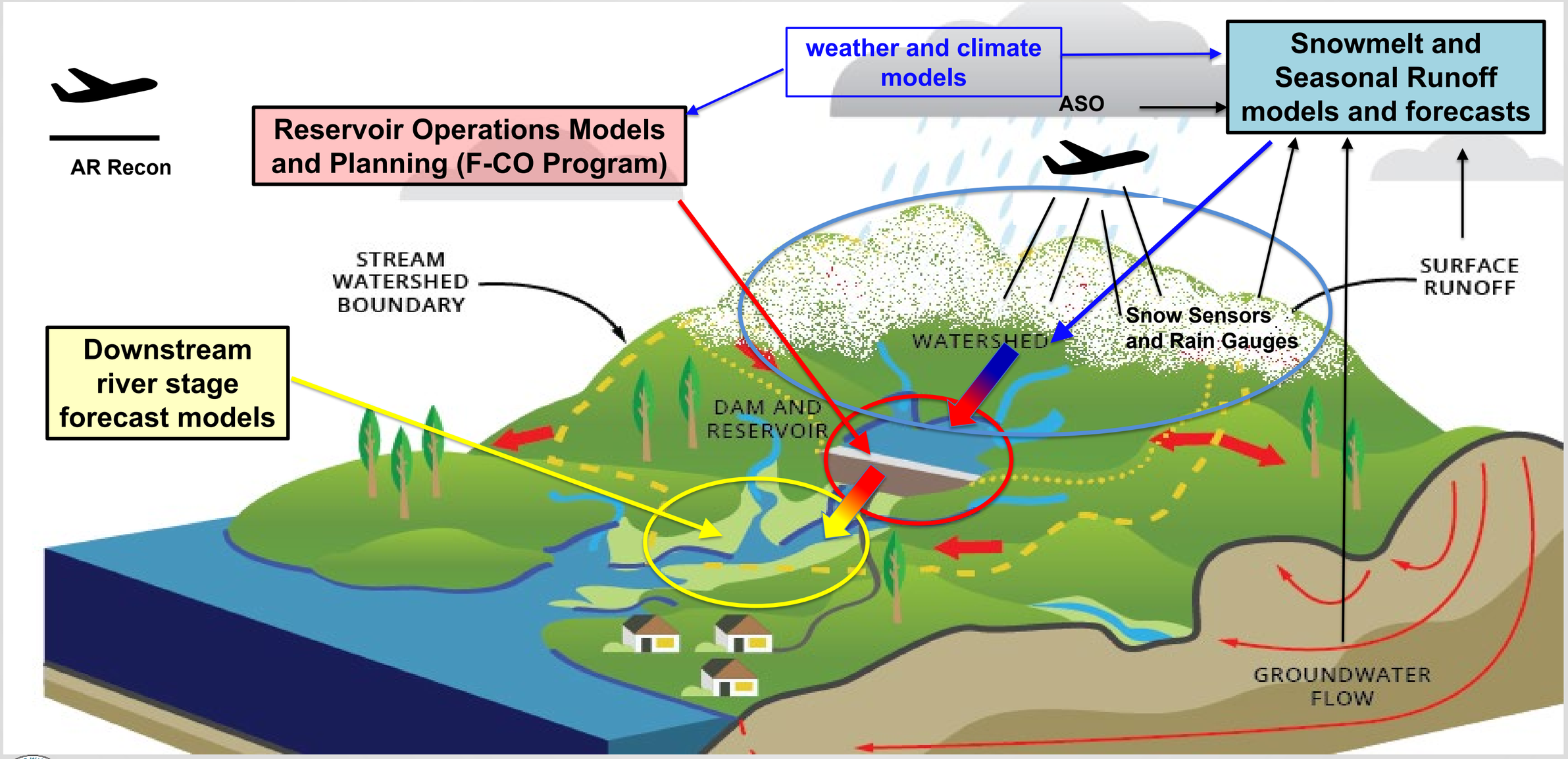
Key Collaborations in Monitoring and Forecasting WY2023



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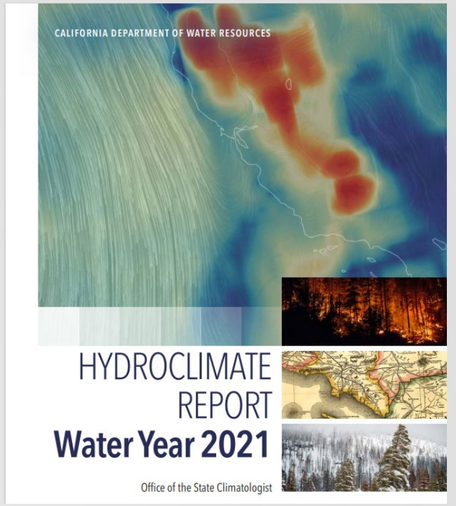
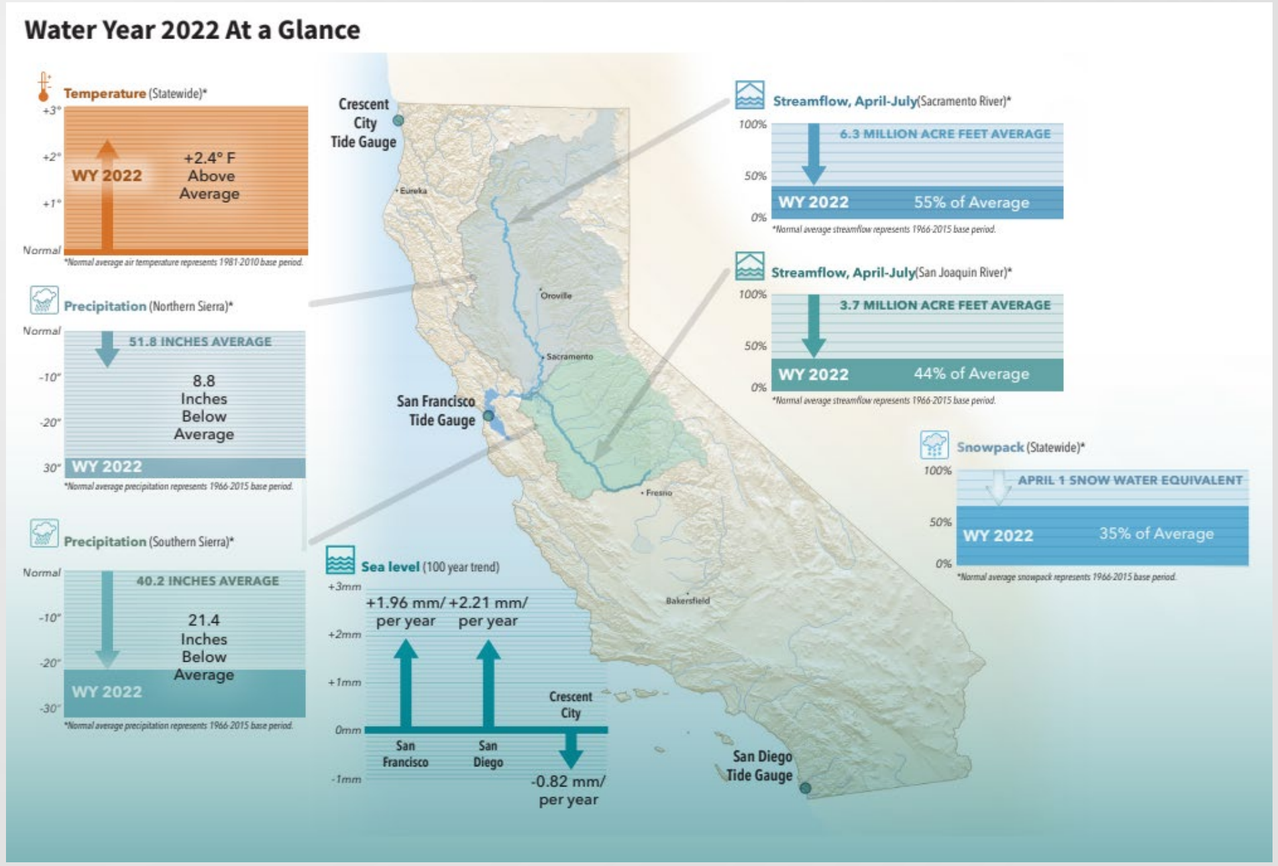
Tracking Change Hydroclimate Report

- Tracks Observed Changes in 5 Areas
- Notes Extremes and New Records
- Adding Dynamic Web Content for 2023 Report





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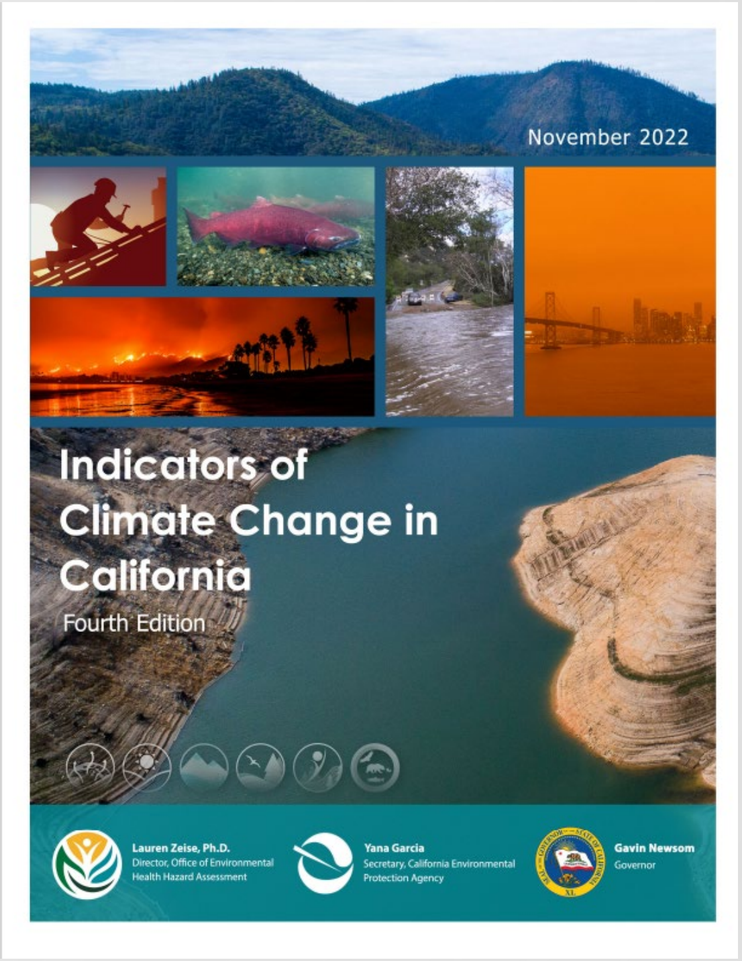
California Indicators of Climate Change

- 2023 Fourth Iteration
- Grouped into categories:
  - Drivers
  - Climate
  - Physical System Impacts
  - Vegetation and Wildlife
  - Human Health
  - Tribes



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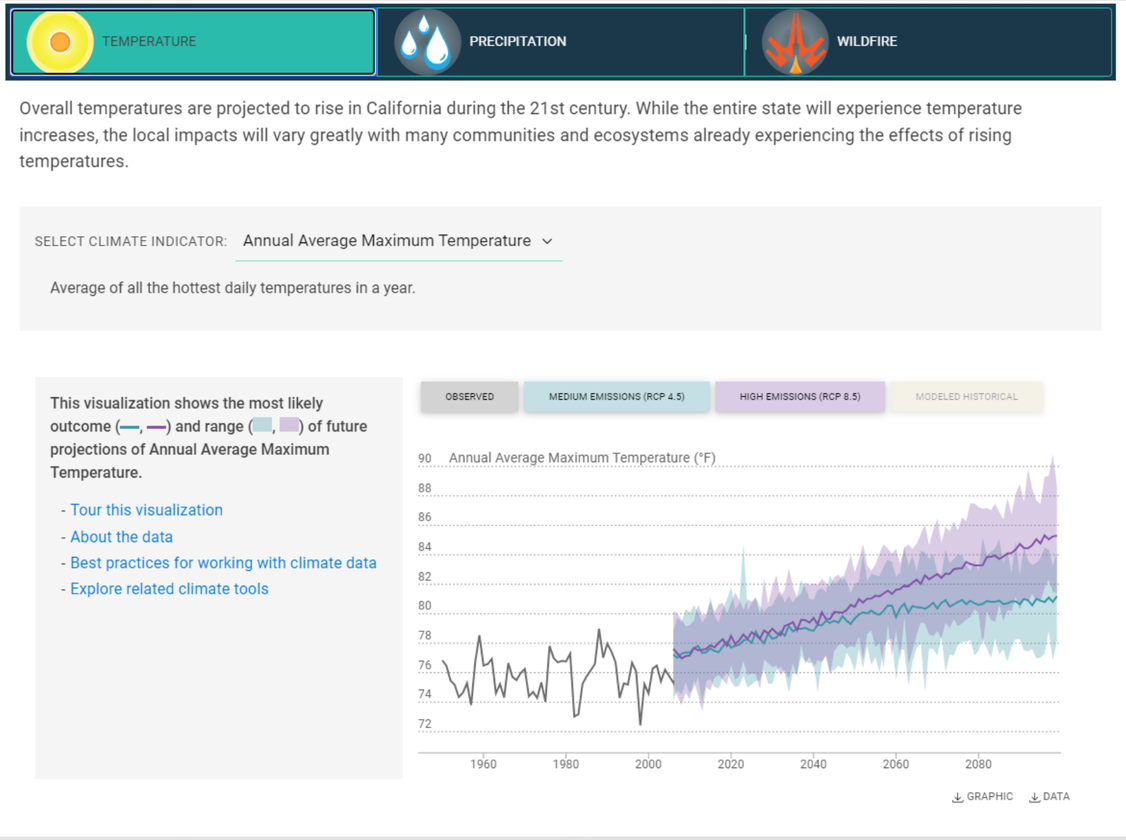
Climate Assessments

Cal-Adapt: Clearinghouse for California Climate Change Data



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End of Century Expectations

- Mean Temperature Rise of 5-8 degrees F
- No strong signal in precipitation – highly variable
- Loss of 2/3 of seasonal snowpack
- Runoff timing changes due to loss of snowpack
- Around 20 inches of sea level rise

Closing Thoughts

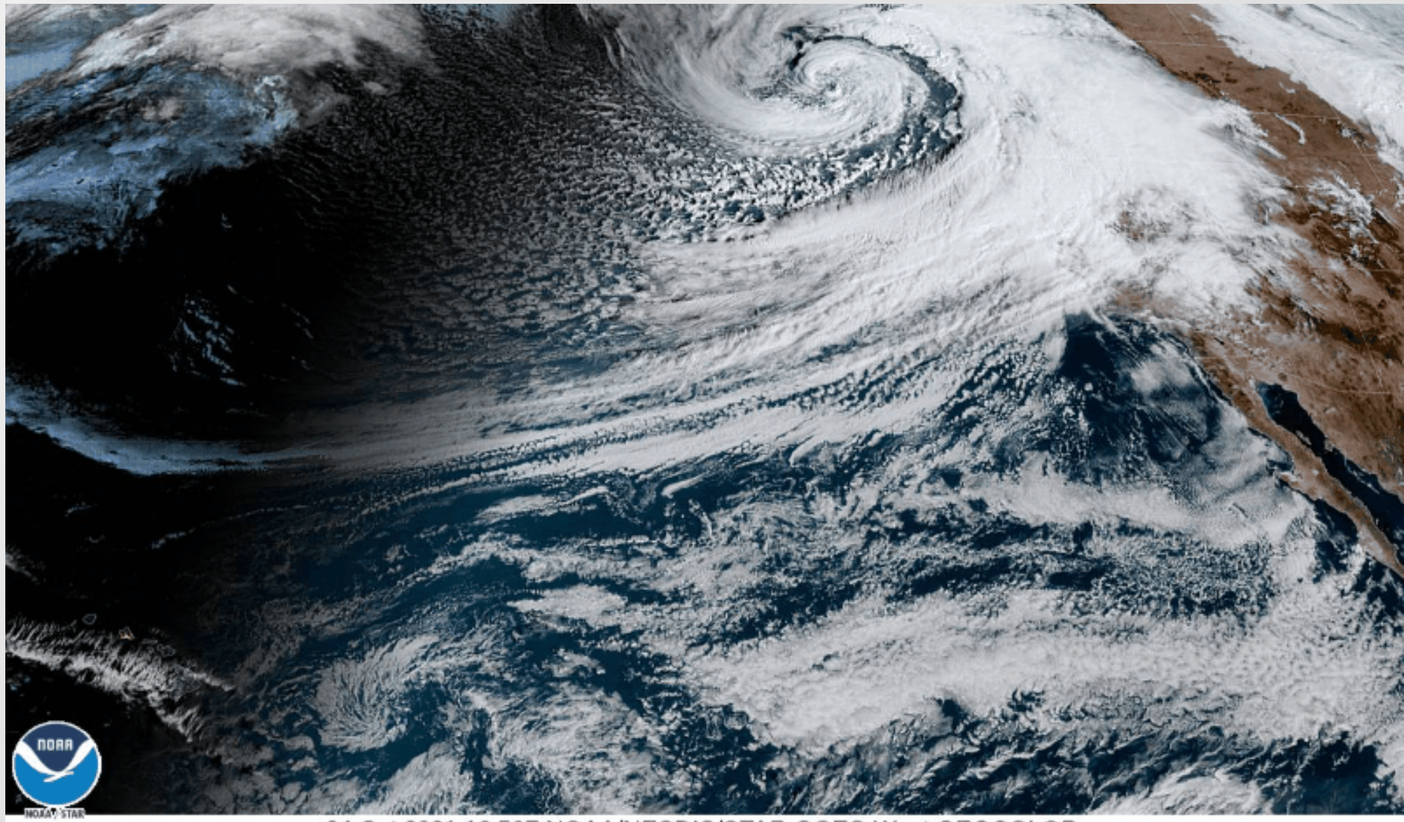
- A warming world has already shown new and more frequent extremes impacting water management actions.
- Expectations are for these extremes to amplify further leading to longer dry spells between larger storms requiring adaptation strategies to maintain supply reliability and reduce flood risk.

Closing Thoughts

- More spatially explicit data at more frequent time intervals is key to understanding the state of the watershed.
- Forecast improvements provide key information at longer lead times to enable greater clarity in available flexibility to meet multiple water management criteria.

Questions?

- Email: Michael.L.Anderson@water.ca.gov



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