Exhibit to Agenda Item #1

Provide the Board an overview of climate impacts projected for SMUD's Upper American River Project (UARP), including an update of statewide trends in water management, highlights from SMUD's 2025 focused study of the UARP, and a discussion of SMUD's projects and operational measures to address historic and future variability.

Board Strategic Development Committee and Special SMUD Board of Directors Meeting

Tuesday, May 12, 2026, scheduled to begin at 6:00 p.m.

Auditorium, SMUD Headquarters Building

Upper American River Project (UARP) Changing Climate Impacts

May 12, 2026

Powering forward.
Together.

SMUD®

Agenda

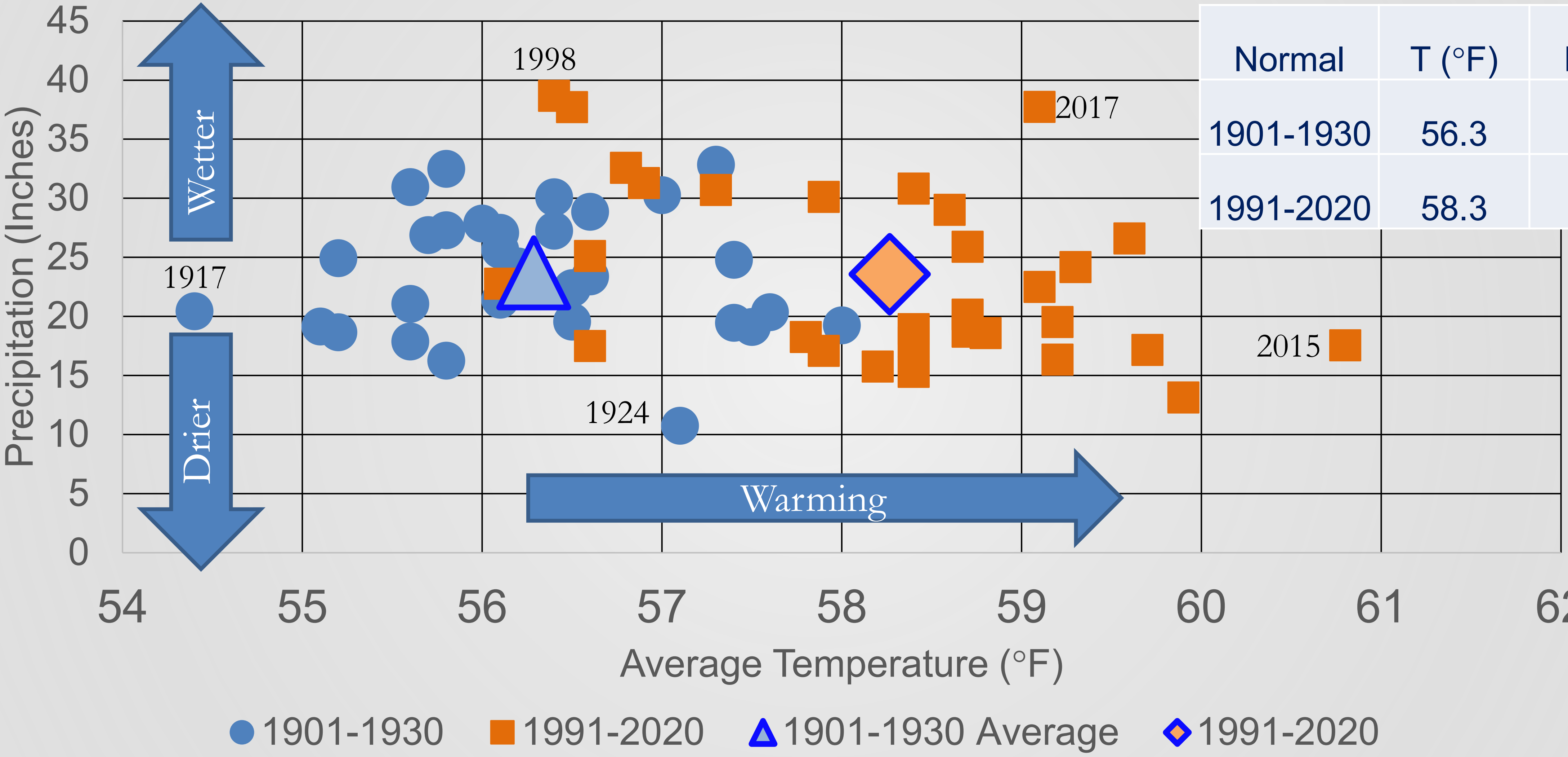
- Michael Anderson, California State Climatologist, Department of Water Resources (DWR) / National Oceanic and Atmospheric Administration (NOAA)
- Dr. Owen Doherty, Principal Research Scientist, Eagle Rock Analytics
- Christine Giannini, Manager Resource Optimization, SMUD
- Josh Langdon, Director Power Generation, SMUD
- Q&A

Raising Managed Water Capability in a Changing Climate

Monet's Water Lillies at the Orangerie, Paris

Michael L. Anderson, State Climatologist

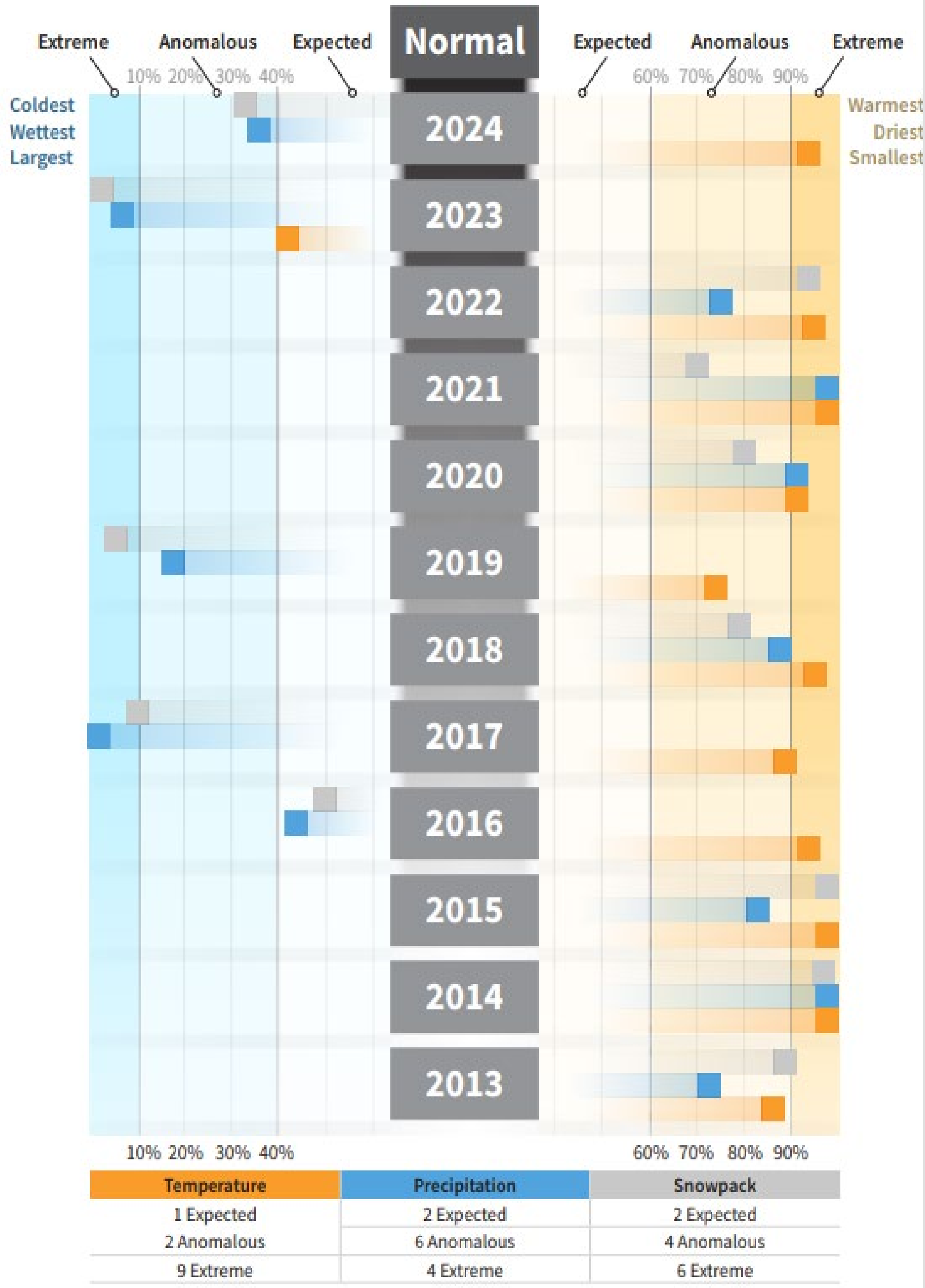
Evolving Normal – 30 Year Averages



Normal	T (°F)	P (in)
1901-1930	56.3	23.7
1991-2020	58.3	23.6

More than a Decade of Extremes

- Multiple Extremes
- New Records
- New opportunities for adaptation



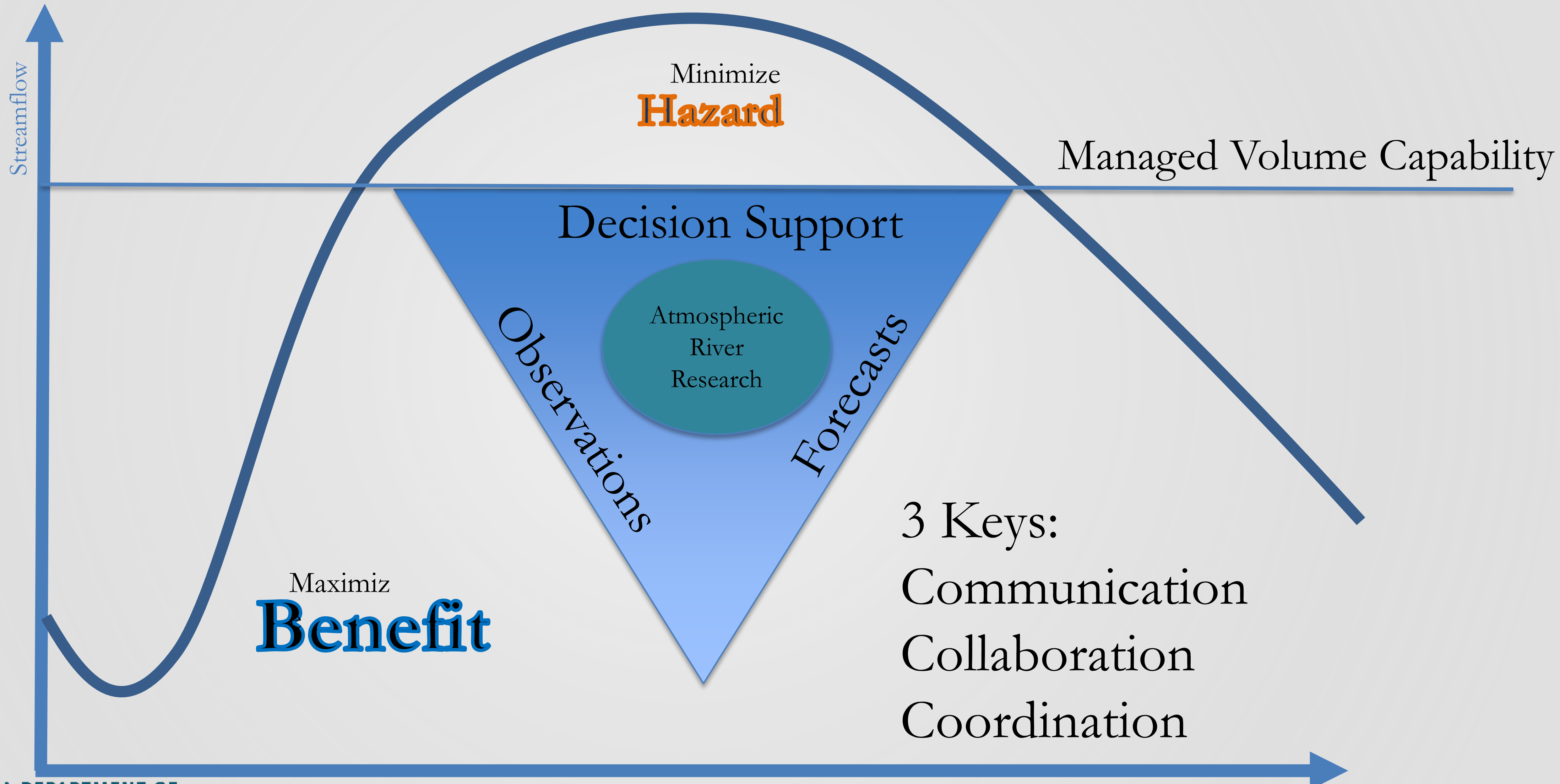
Forecast Informed Reservoir Operations (FIRO) Begins

Building the Water Year

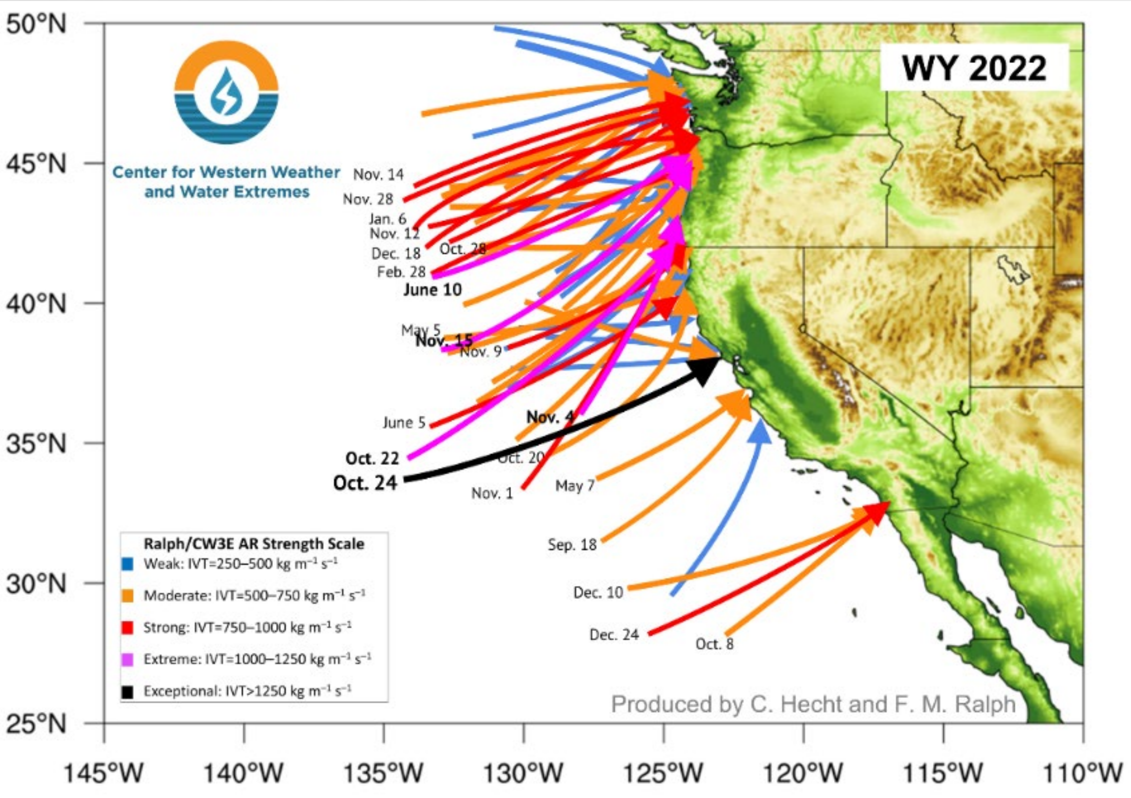
- Fall (October/November)
  - Precipitation Onset
  - Temperature Anomaly
  - Soil Moisture State with Snowpack Initiation
- Winter (December/January/February)
  - Wet/Dry
  - Notable Anomalies
- Spring (March/April/May)
  - Late-Season Bailout or Early Shutoff?
  - Peak Snowpack Timing and Magnitude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

Climate Change: How different will the next decade be?

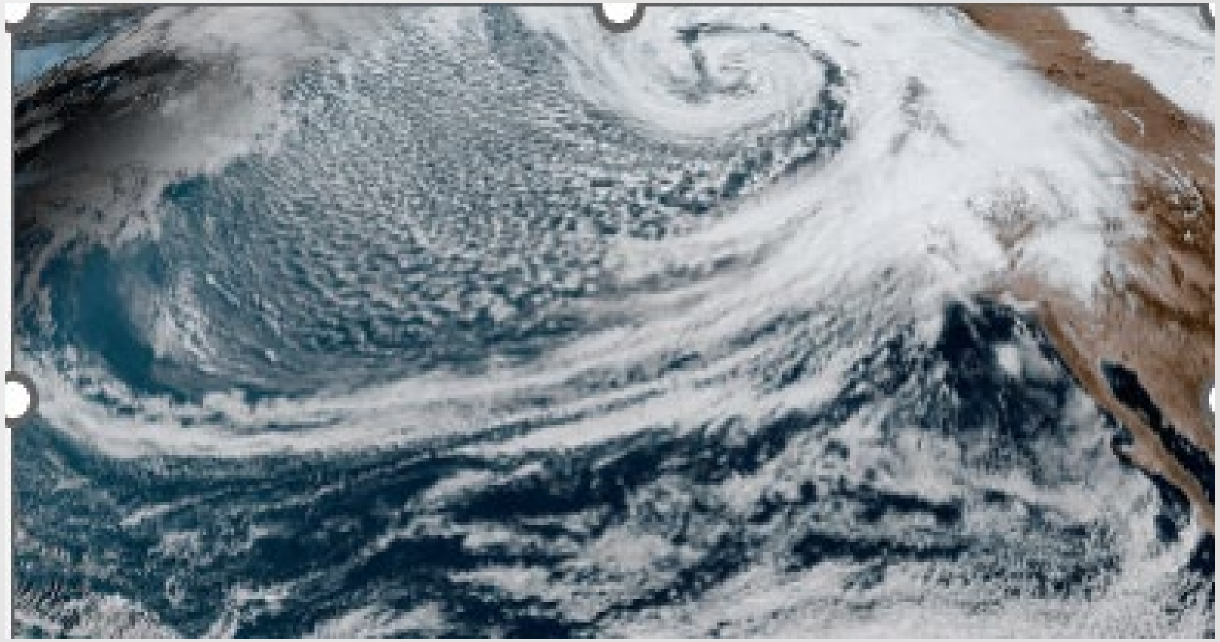
Real-Time Water Management



Atmospheric Rivers

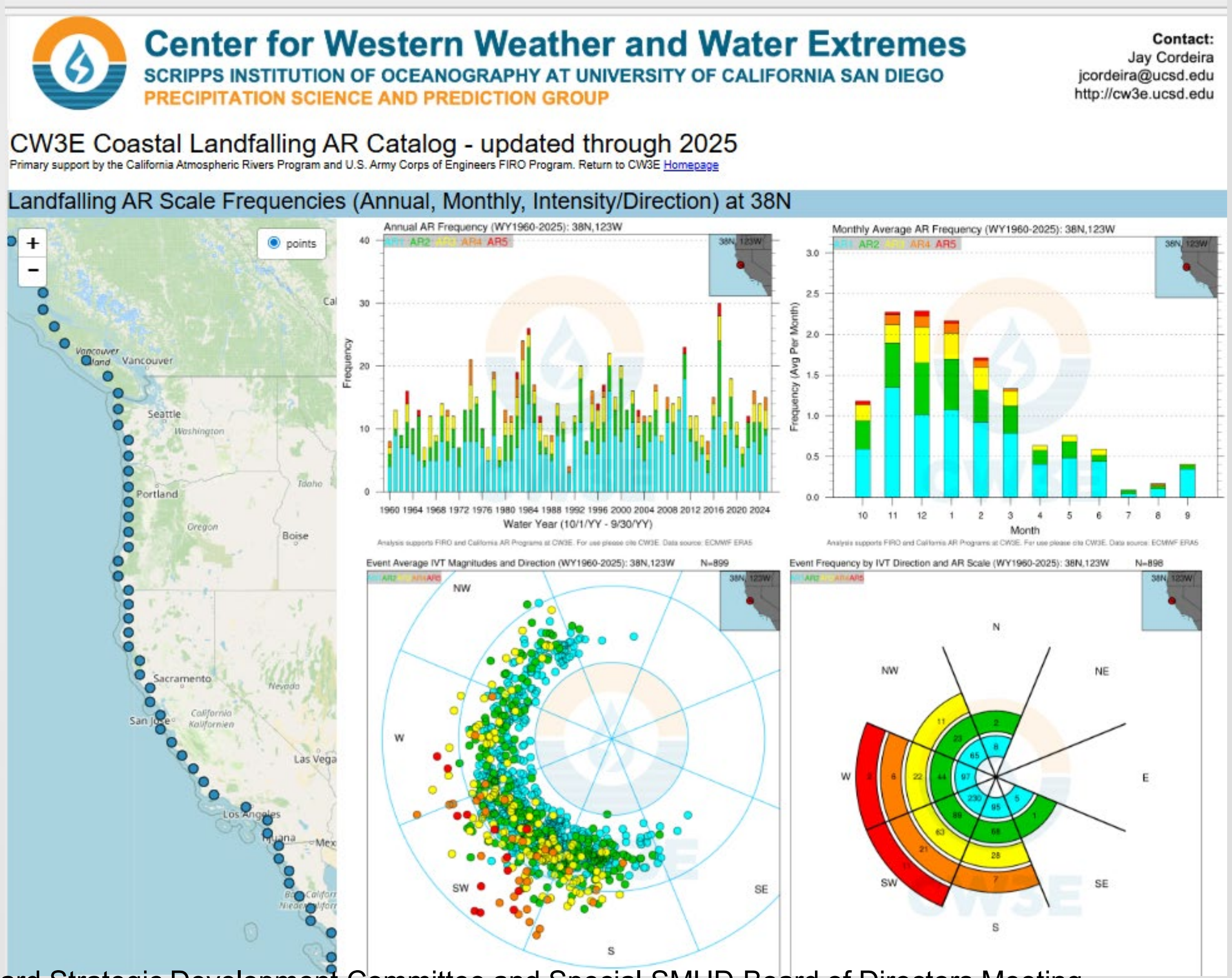


- Key to CA Water Extremes
- Defined physical structure



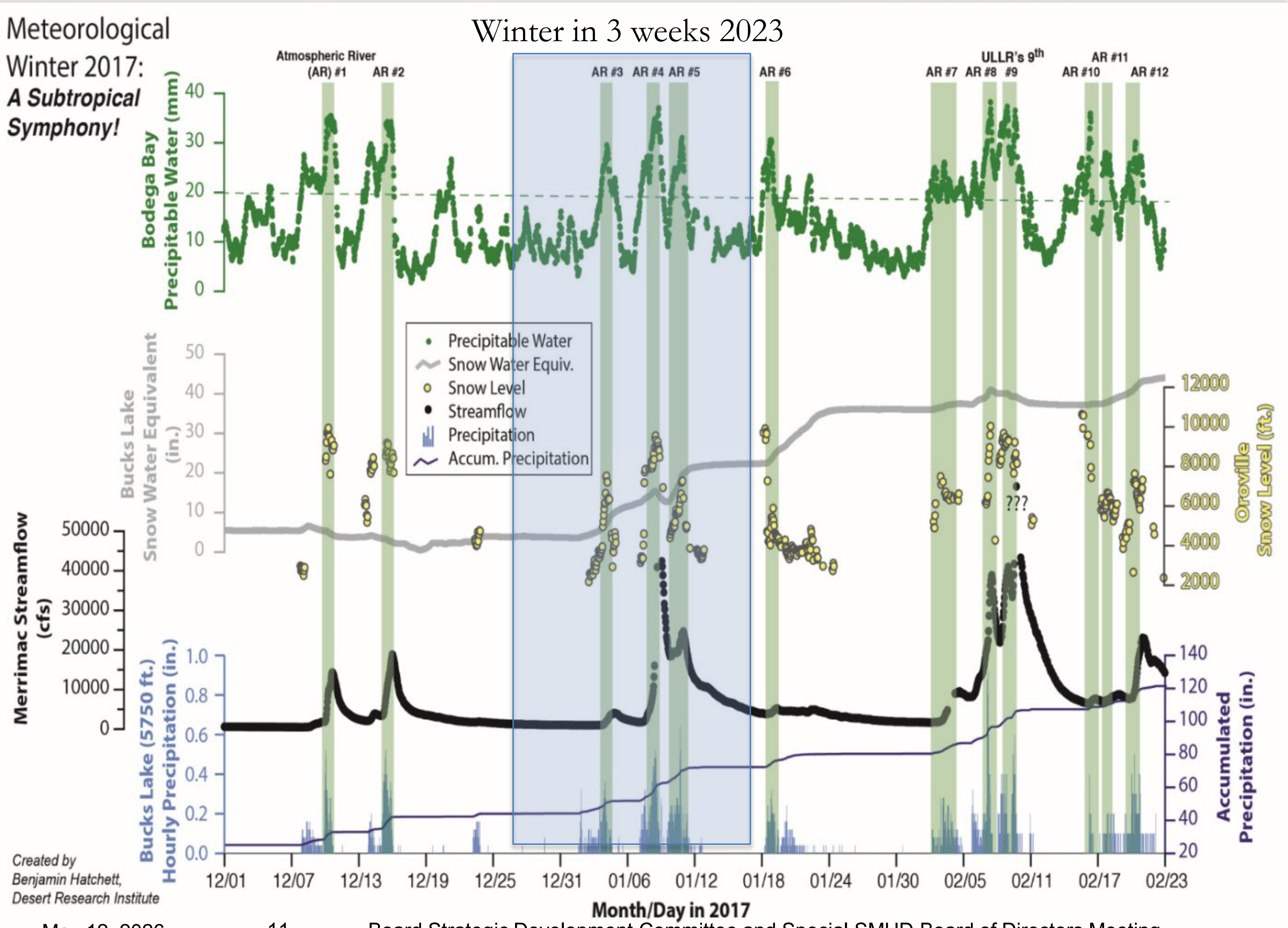
Research and Operations Partnership

- CA has invested in better forecasting with Center for Western Weather & Water Extremes (CW3E)
- CW3E's research into atmospheric river characteristics creates better observations and forecasts
- https://cw3e.ucsd.edu



What is:
- Now?
- Next?
- On the Horizon?

- What information is available?
- What is useful?
- How is it presented?

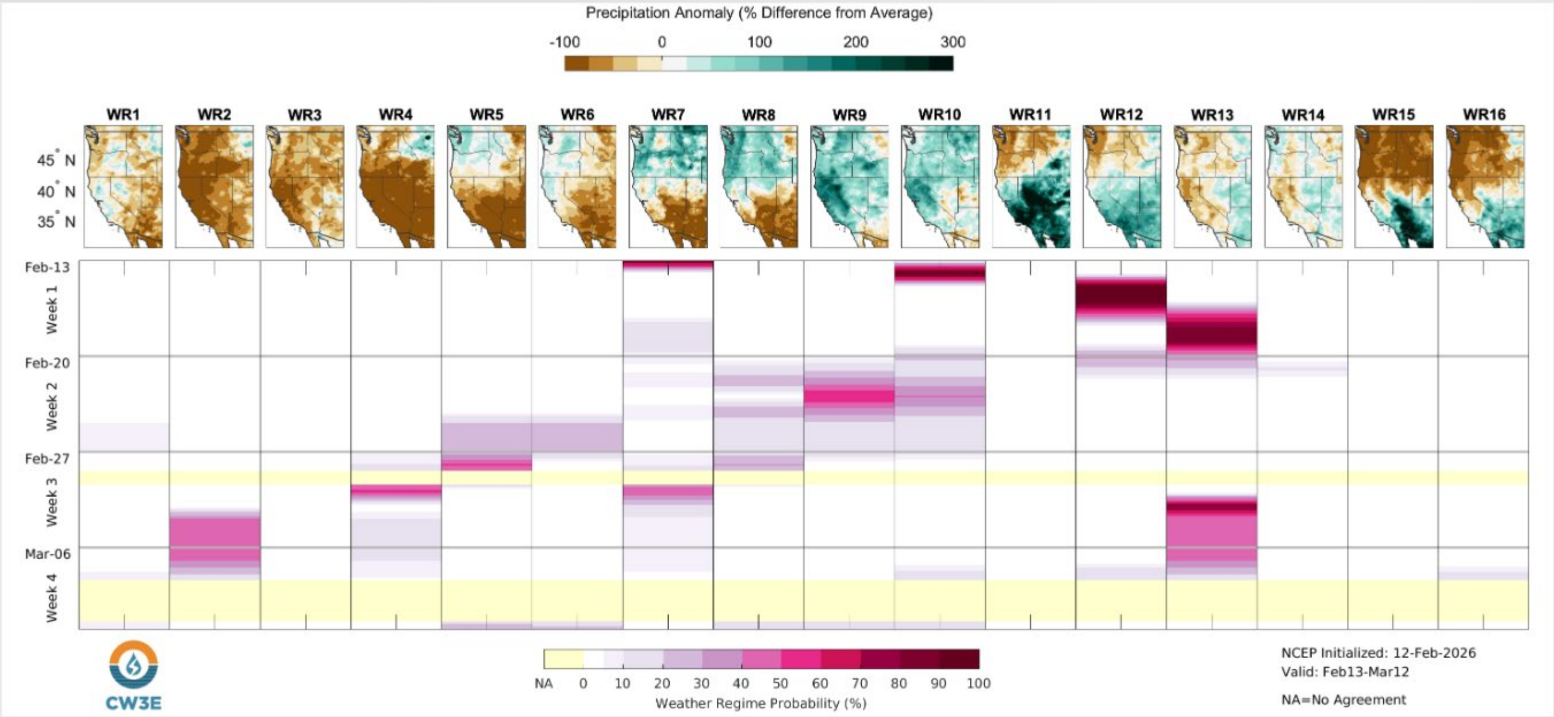


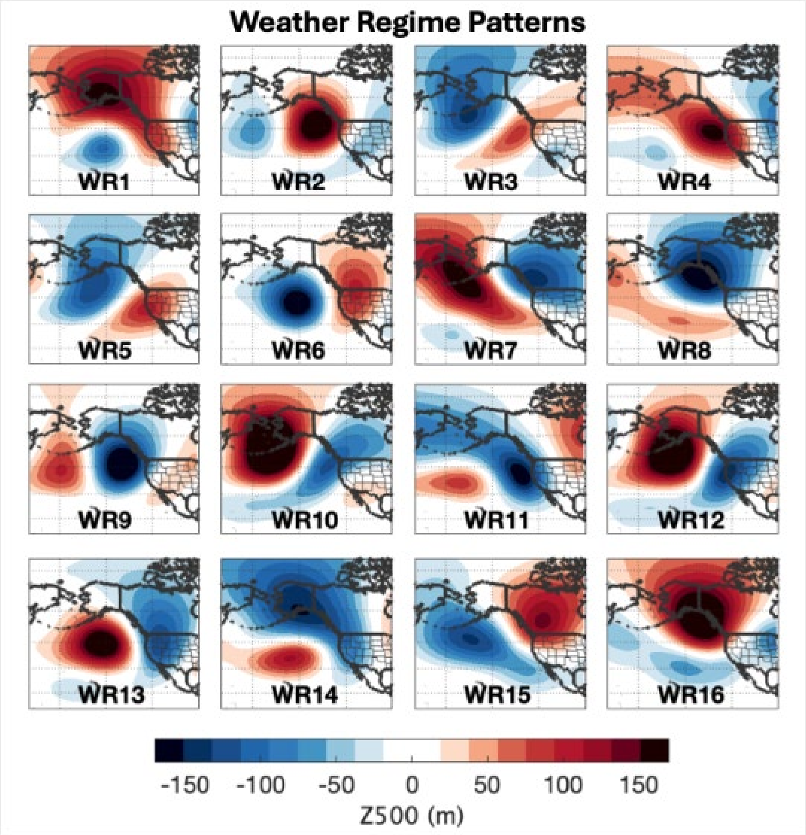
Partnership: Western Region Climate Center

Additional S&S Forecasts/Outlooks

Subseasonal and Seasonal (S&S) Forecasts - Center for Western Weather and Water Extremes

Weather Regime Tool





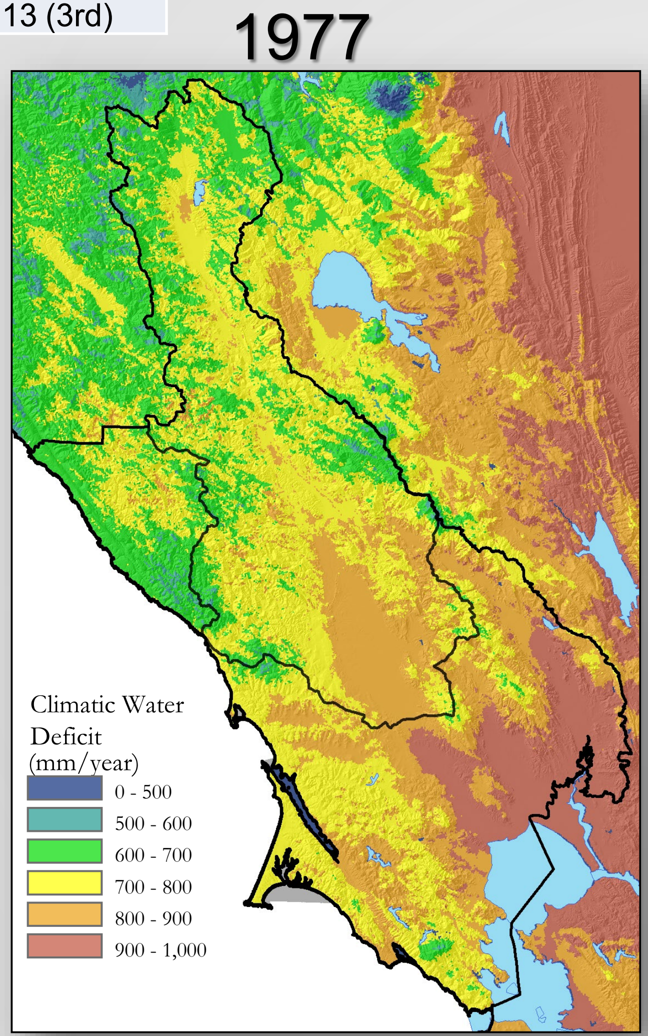
What is the Advanced Quantitative Precipitation Information (AQPI) System?

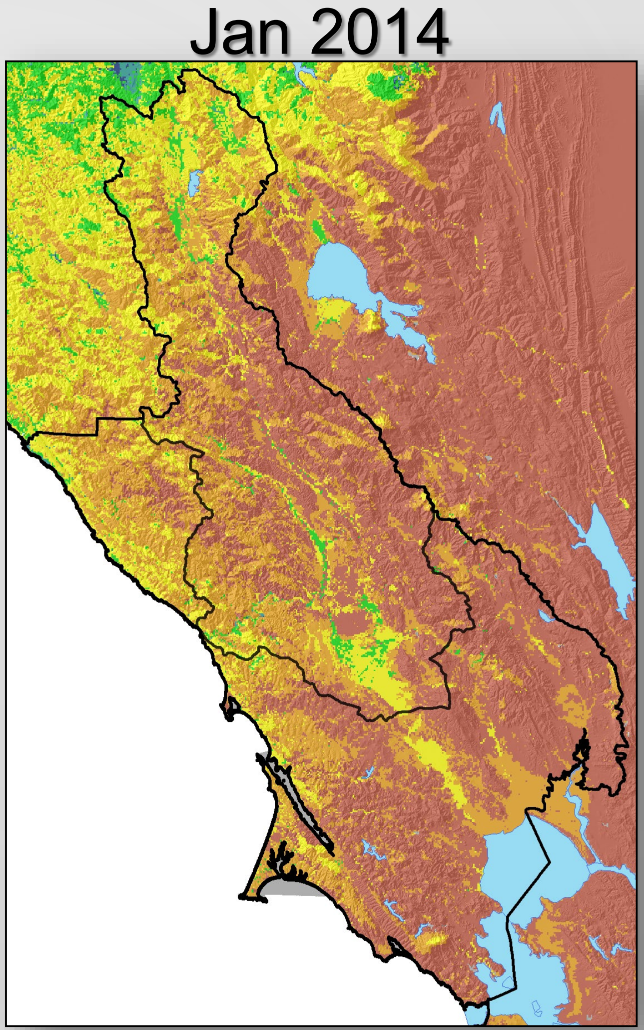
AQPI has several components

- Observations: Additional radars to overcome beam blockage and overshoot, and meet user needs for for spatial and temporal frequency; additional rain/stream gauges for "ground truth"
- Radar-Derived Products: quantitative precipitation estimate (QPE), Nowcast,
  - QPE can be used in Hydrologic & Hydraulic (H&H) models
- Weather Forecasts: short- and medium-range forecasts of precipitation and other relevant elements
- Coastal Modeling: tides, waves, storm surge, coastal flooding and inundation

Water Year	Temperature deg F	Precipitation inches
1977	57.4 (21st)	11.94 (2nd)
2014	59.9 (1st)	13.13 (3rd)

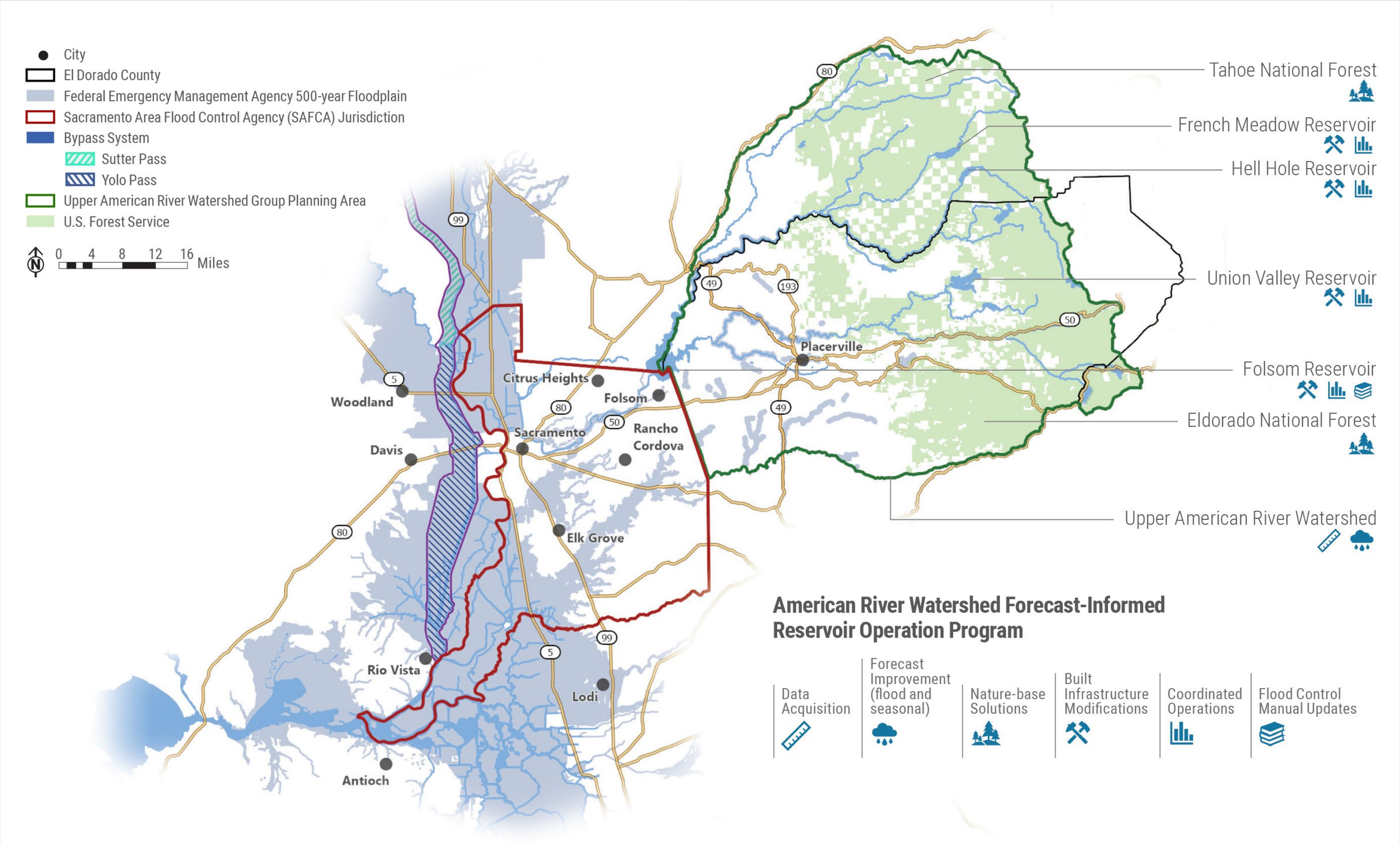
Landscape drought: The influence of temperature





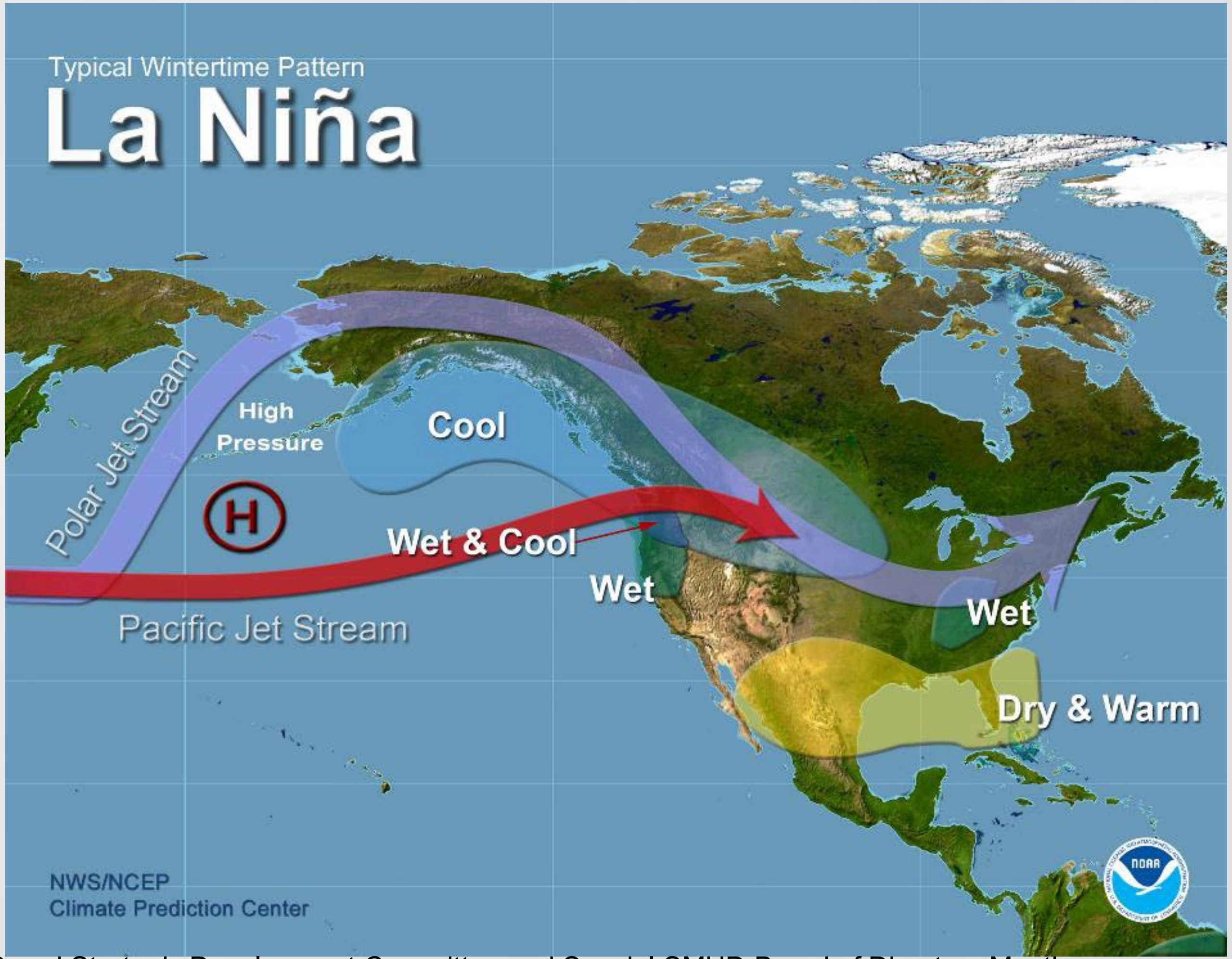
Partnership: US Geological Survey (USGS)/Earth Knowledge

American River Watershed FIRO Initiative



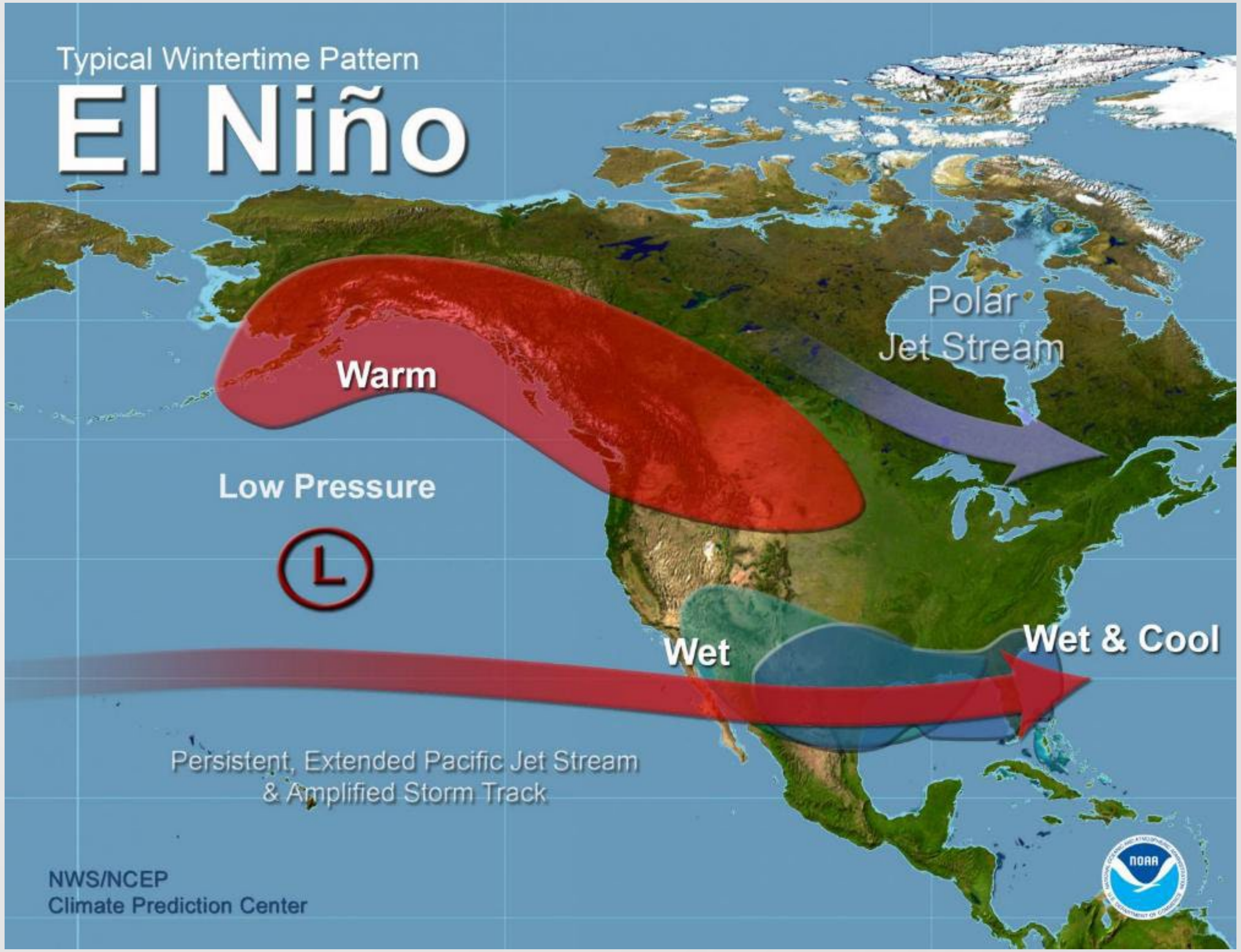
El Nino-Southern Oscillation (ENSO) Impacts Wintertime Storm Tracks

- Follow the High Pressure location and strength
- Watch for cold-air outbreaks
- Watch for long-duration atmospheric rivers



ENSO Impacts Wintertime Storm Tracks

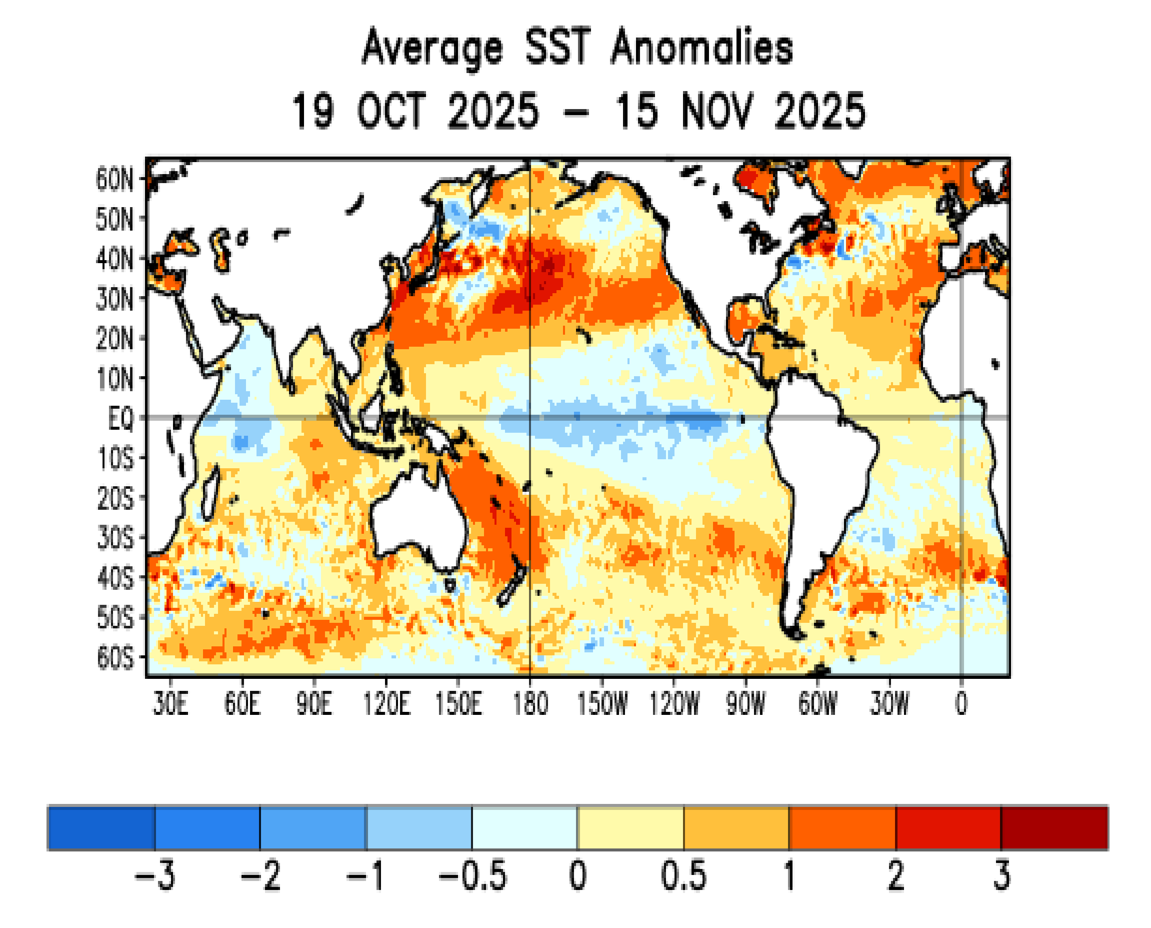
- Jet stream flat and fast
- Displacement to the south determines CA impacts
- More quick storms and coastal damage likely



National Weather Service (NWS) / National Centers for Environmental Prediction (NCEP)

Marine Heat Anomalies

- What is different now versus 1980s?
- What studies are worth revisiting?
- What additional knowledge is available to incorporate into new expectations?



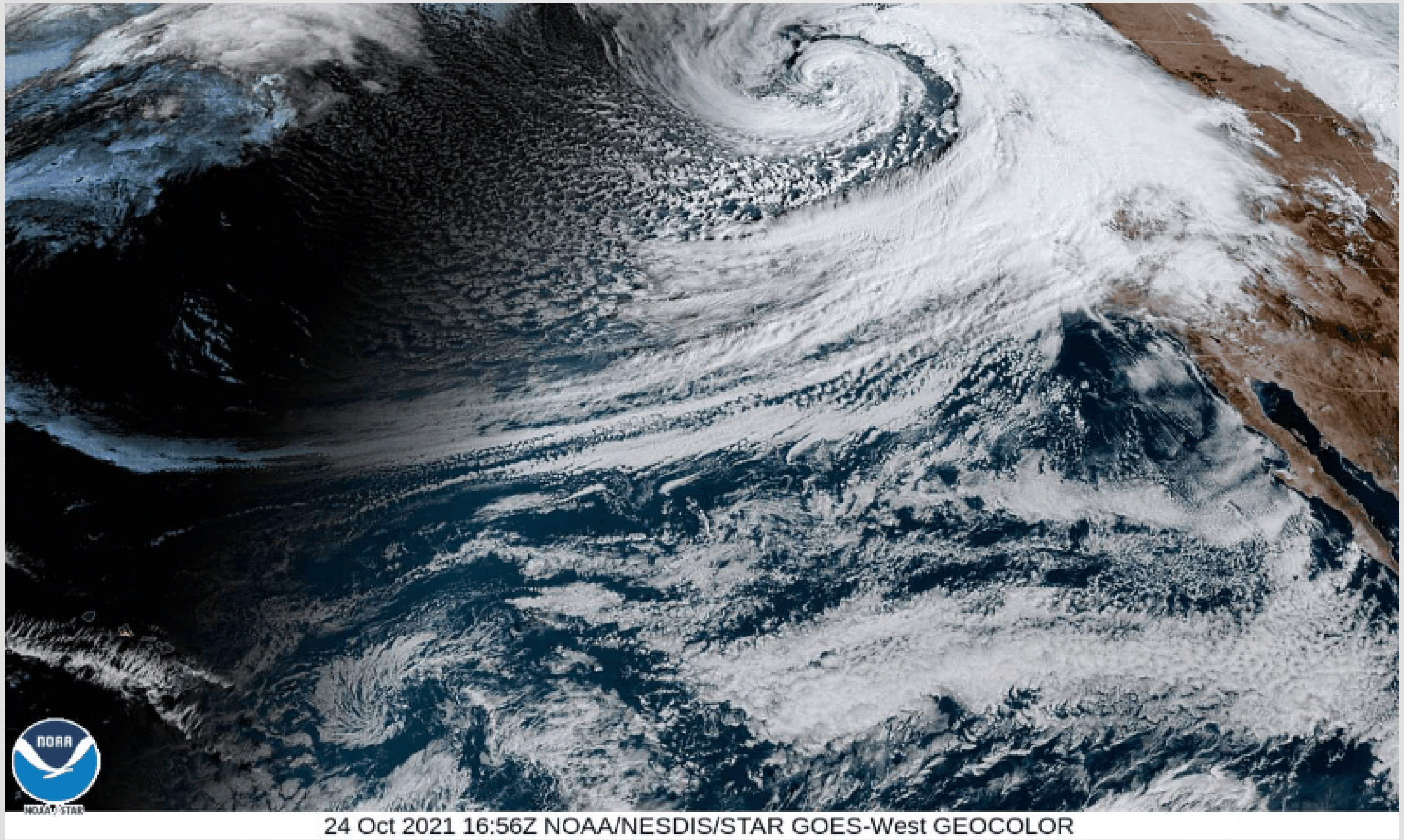
Sea Surface Temperature (SST)

Closing Thoughts

- The consequences of a warming world have started.
- Expect the challenges to amplify.
- The right tools informing the right actions communicated at the right time in the right way will enable us to thrive in this new world that is taking shape and evolving.
- Partnerships can enhance opportunity for success.

Questions?

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



Climate Change Impacts to the Upper American River Project

Strategic Development Committee
May 12th, 2026

Owen Doherty, Ph.D.
Eagle Rock Analytics - Sacramento, CA

Key Takeaways

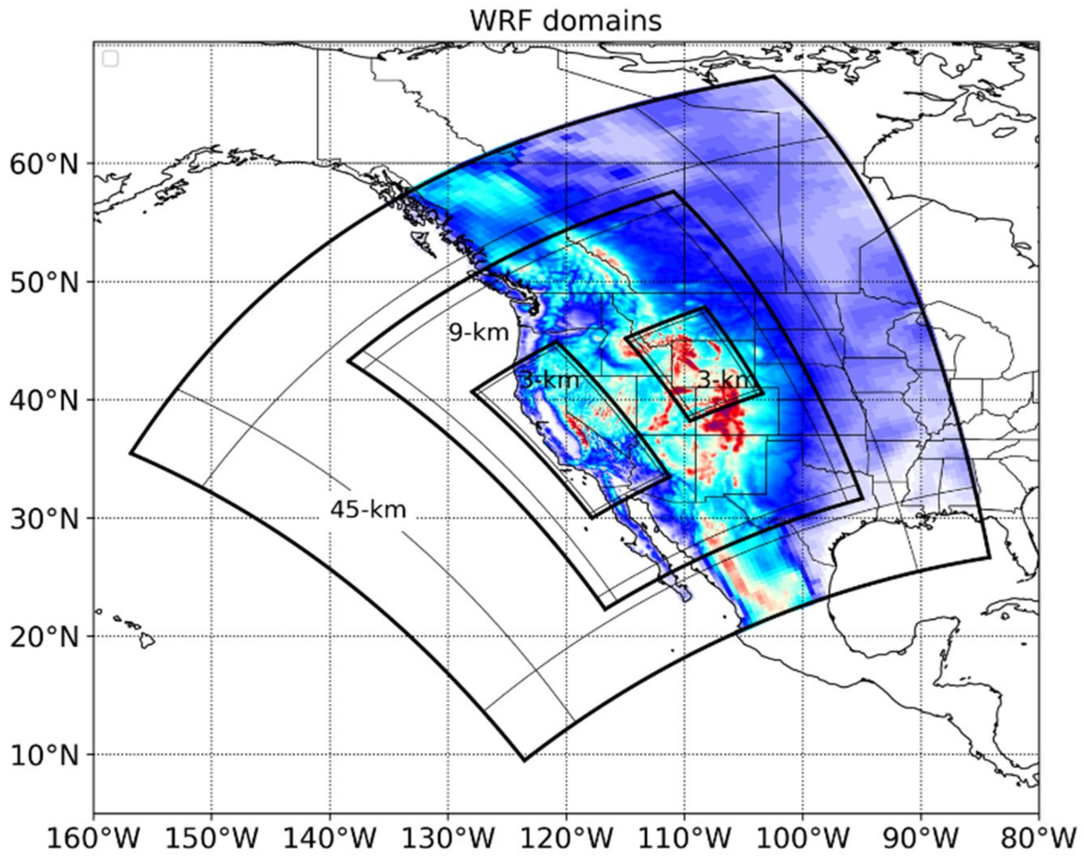
1. Expect changes in when in seasons precipitation occurs

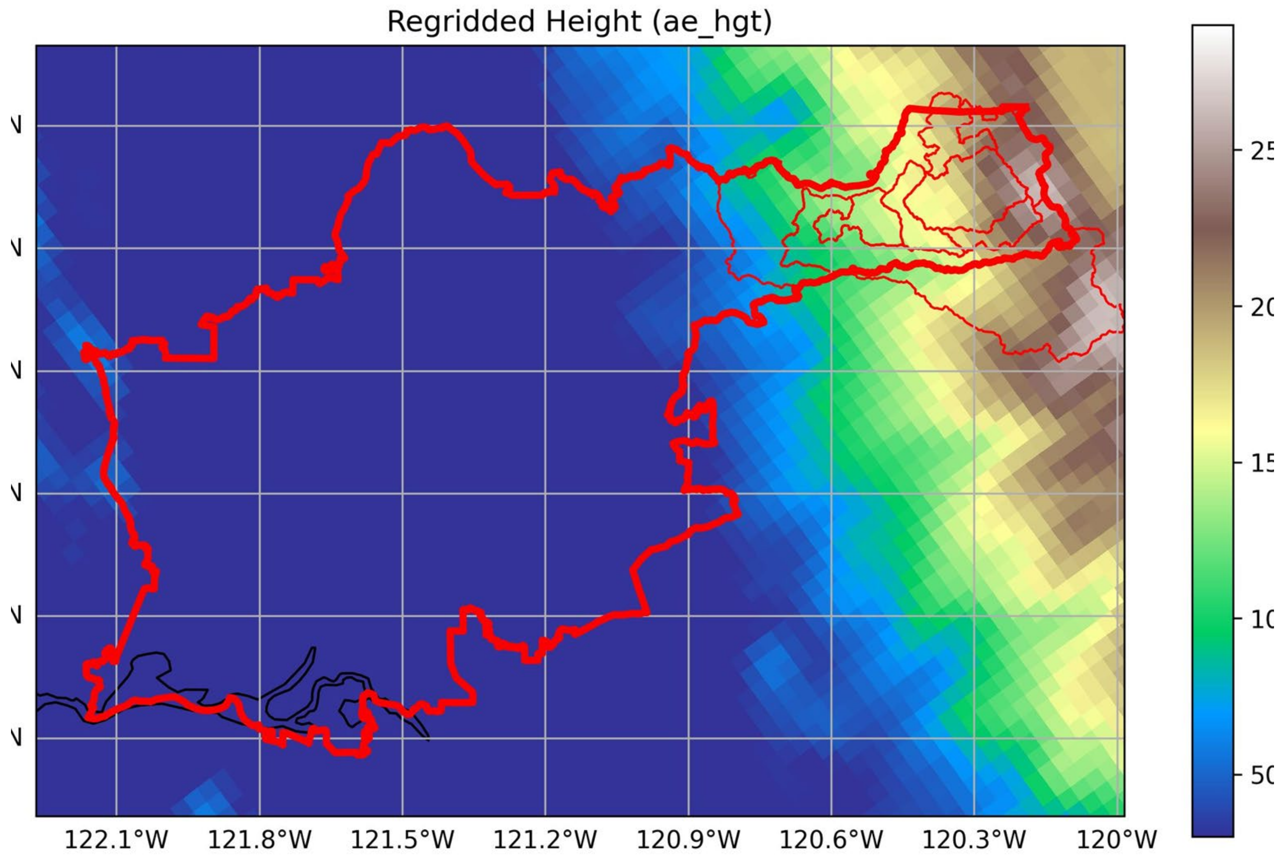
2. The number of days with precipitation will not change, but the amount of precipitation will

3. The snowpack will be reduced, particularly at lower elevations

4. The reduction in snowpack is not uniform across the year, but rather focused on fall and spring season snowpack

The Approach

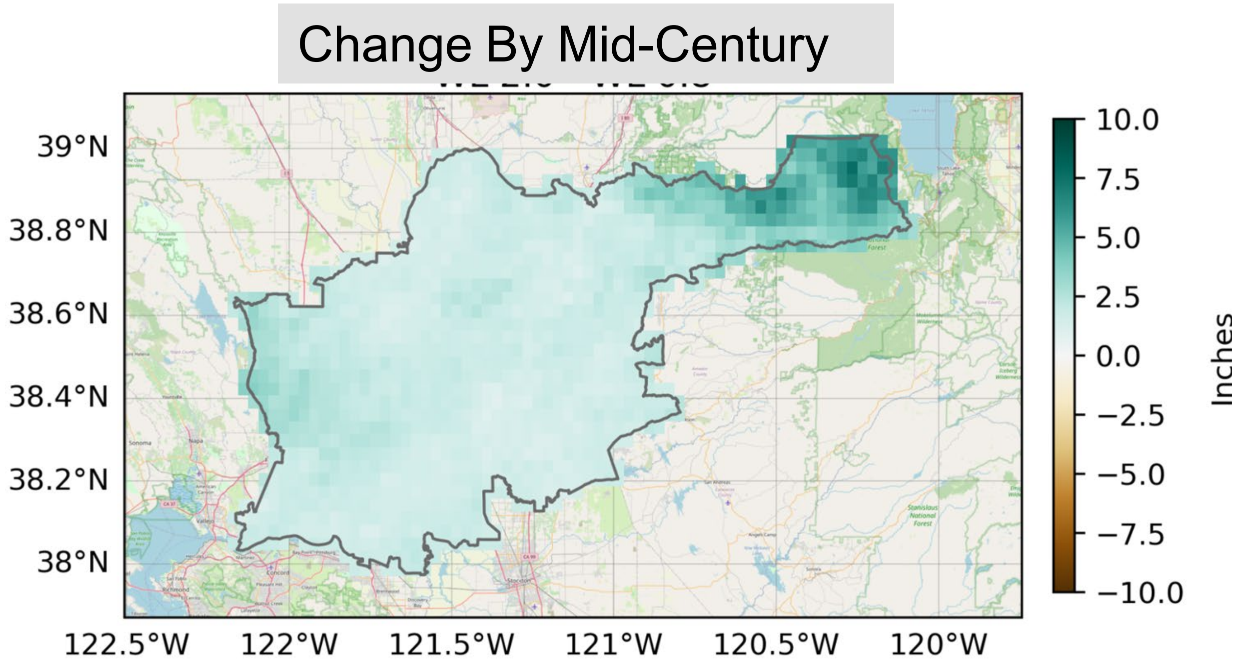




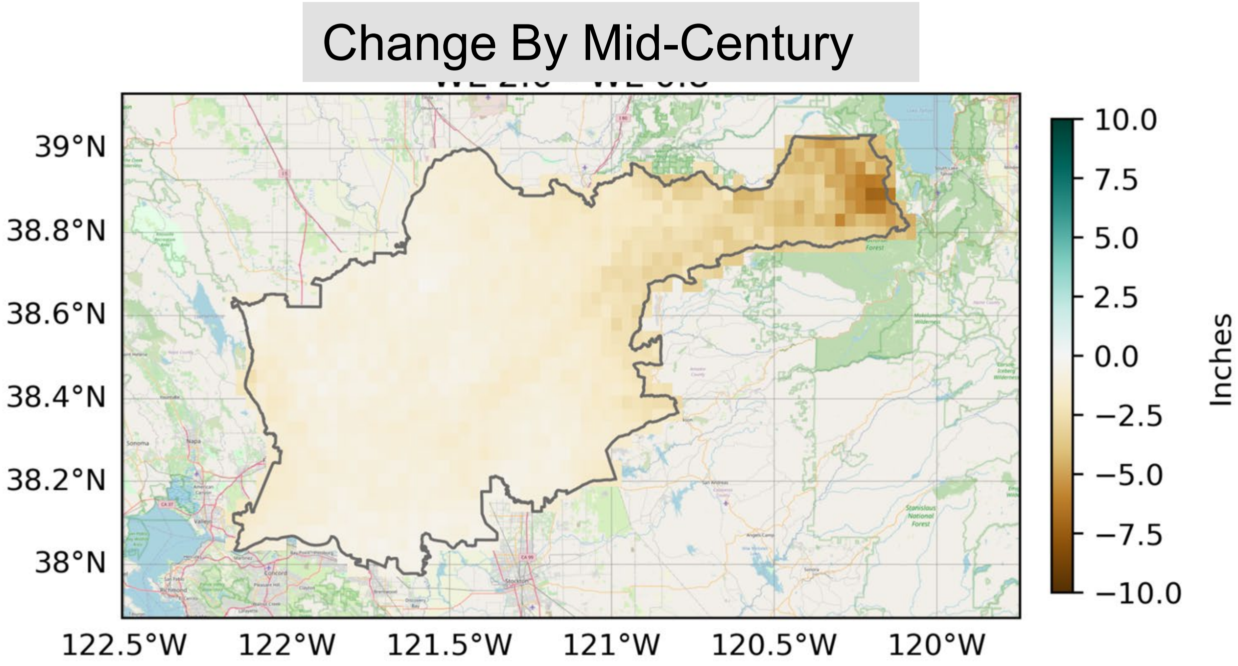
Source: Stefan Rahimi, UCLA

The Approach

Wet Models

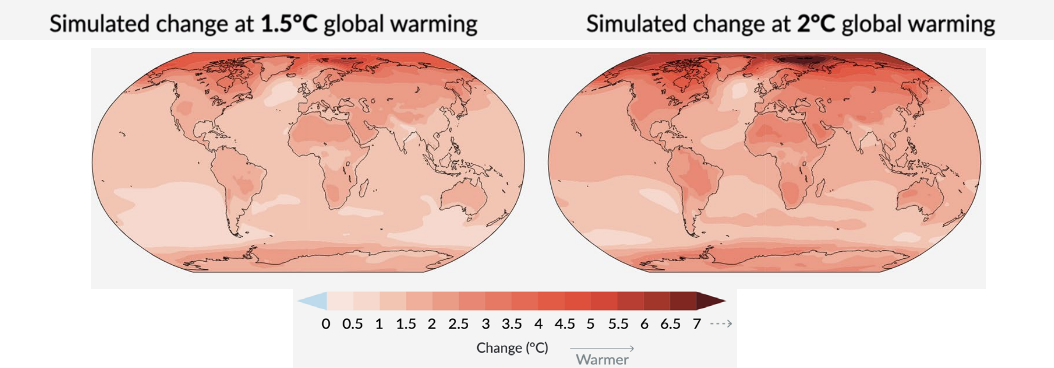


Dry Models

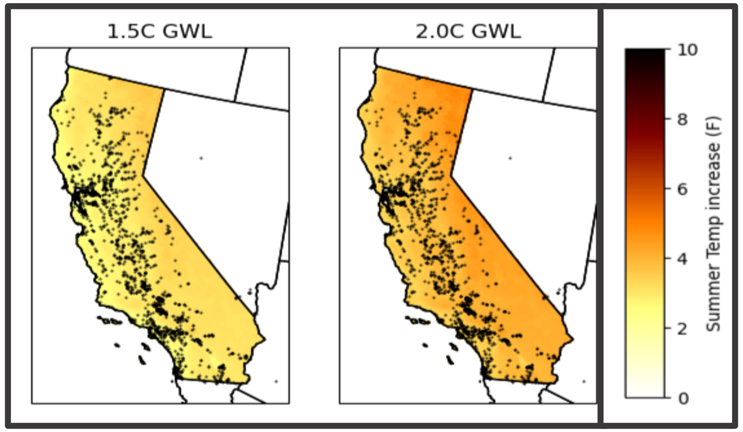


The Approach

	Global Warming Level	Best estimate year
Historical baseline	0.8 °C	2002
Recent historical	1.0 °C	2010
"Present day"	1.2 °C	2020
Next 10 years	1.5 °C	2031 (SSP 3-7.0)
Mid-Century	2.0 °C	2047 (SSP 3-7.0)
Next 50 years	3.0 °C	2075 (SSP 3-7.0)



https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf

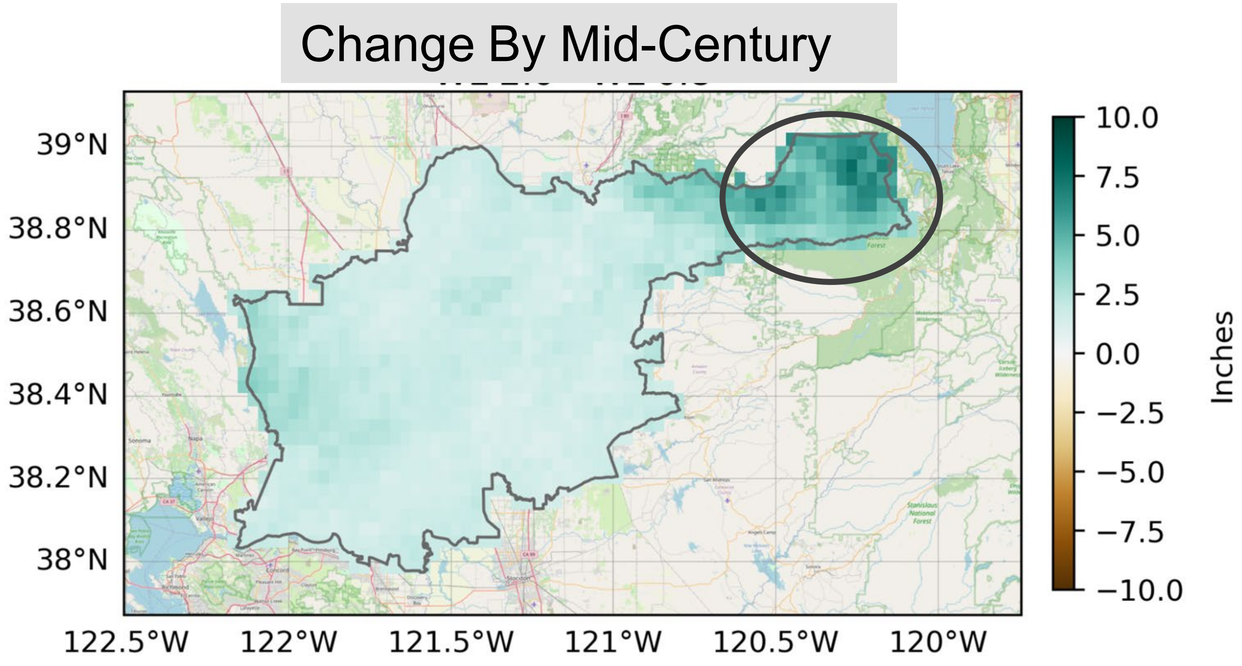


Key Finding : Seasonal Changes in Precipitation

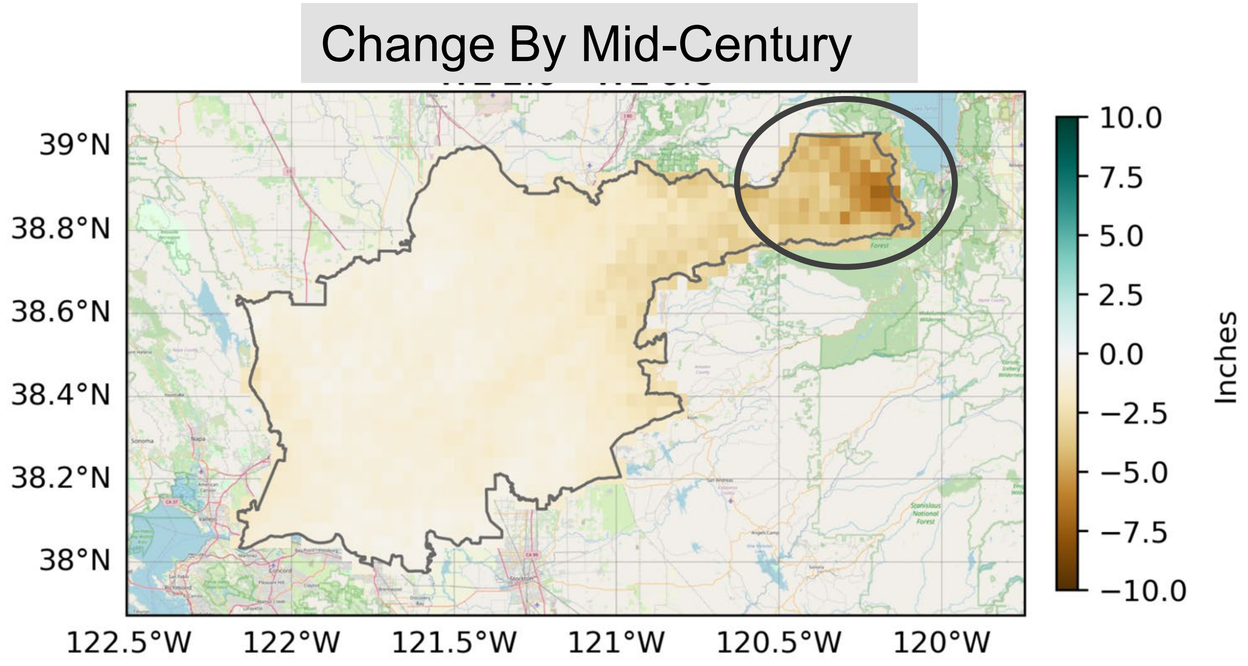
EAGLE ROCK ANALYTICS

Average Annual Precipitation

Wet



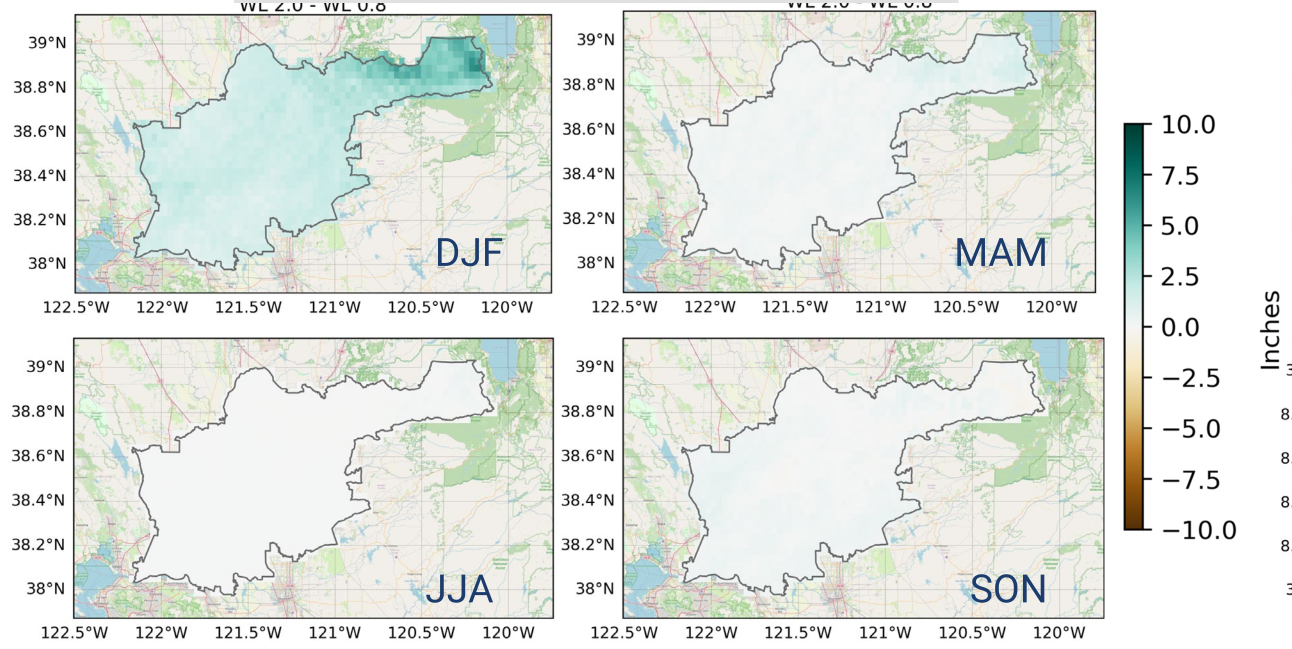
Dry



Average Seasonal Precipitation

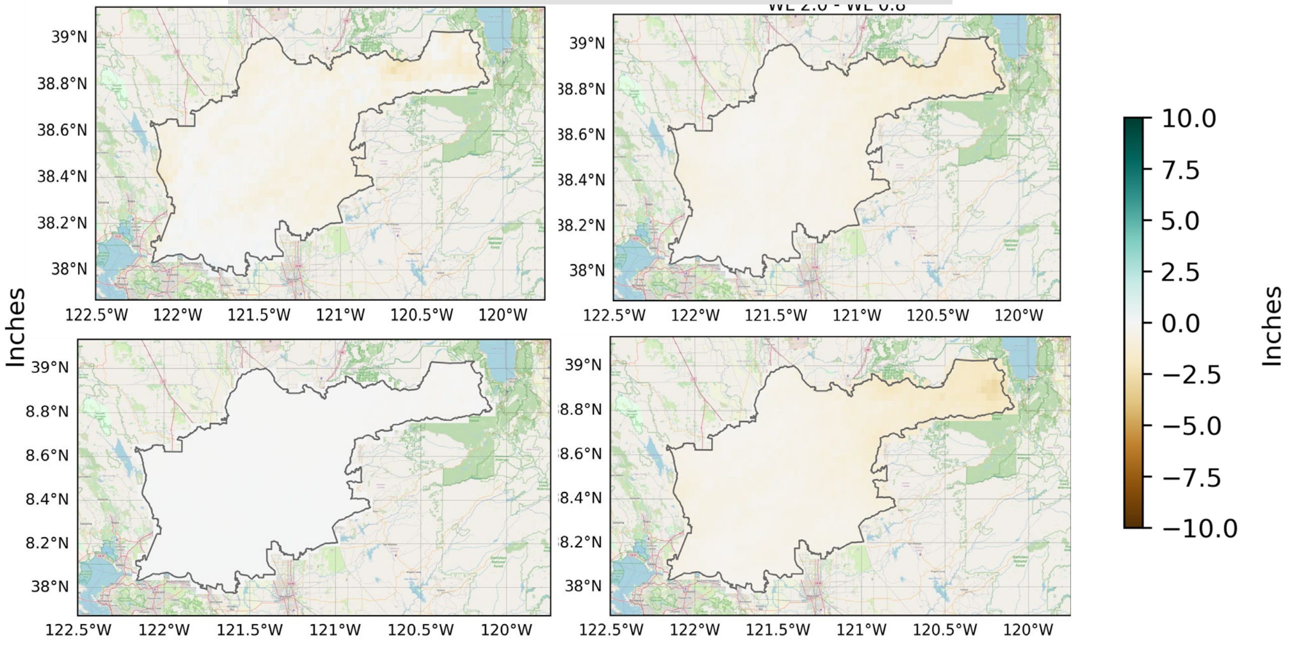
Wet

Change By Mid-Century



Dry

Change By Mid-Century



Impacts

- Wide range of possible future outlooks, increasing in variability
- For the wet future - most of increase in precipitation occurs during winter
    - Spring and fall show modest changes
- For the dry future - decrease of precipitation spread out across seasons
    - Drying spread across seasons
- Changes in precipitation include both rain and snow

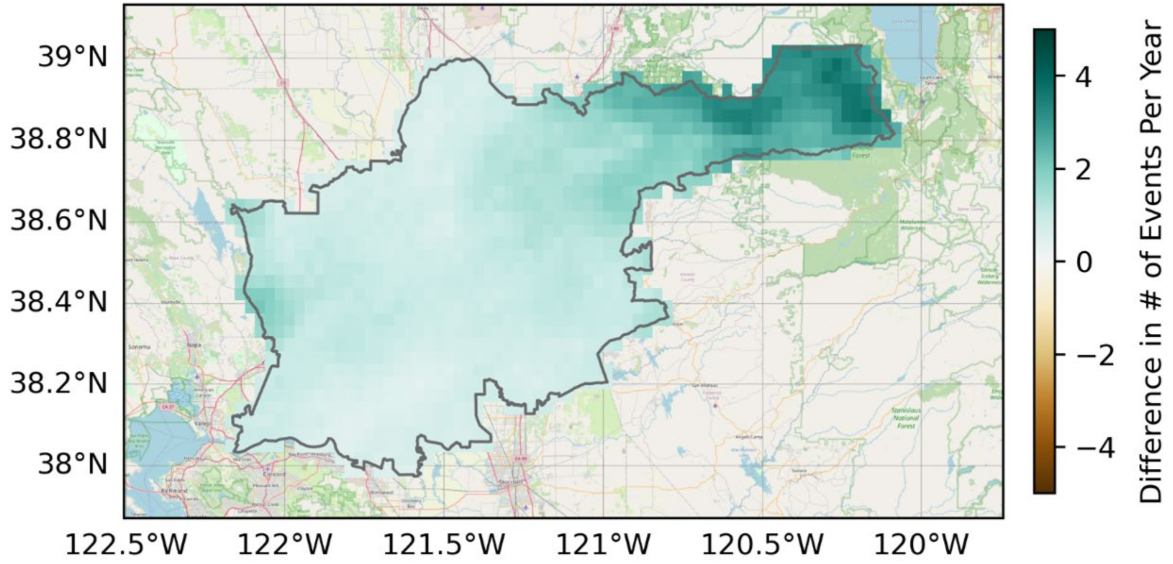
Key Finding: Heavy Precipitation

EAGLE ROCK ANALYTICS

of Wet Days per Year

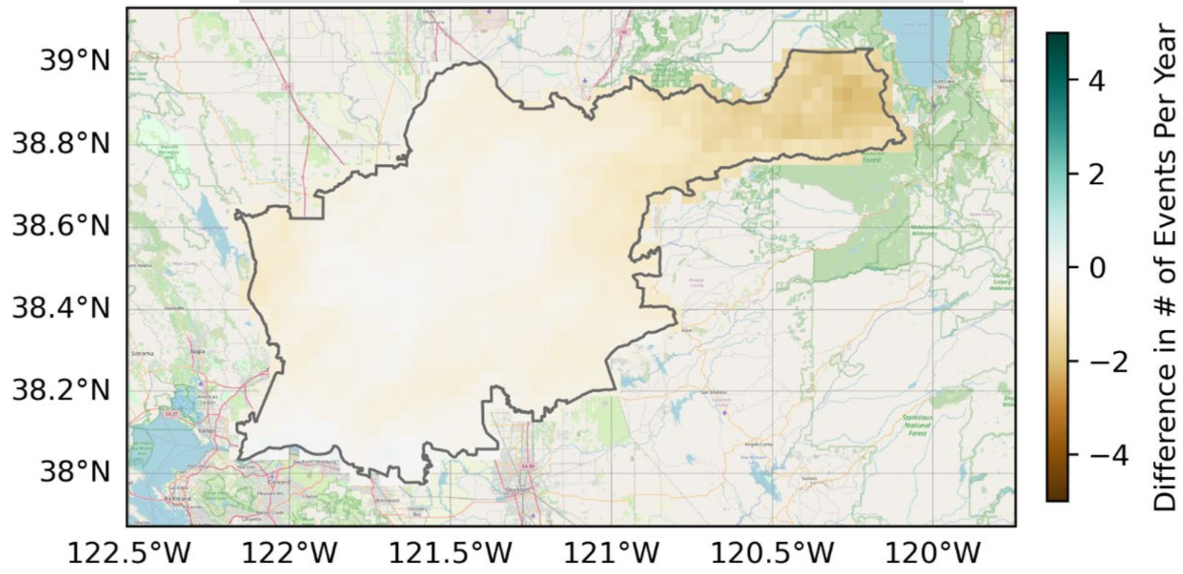
Wet

Change By Mid-Century



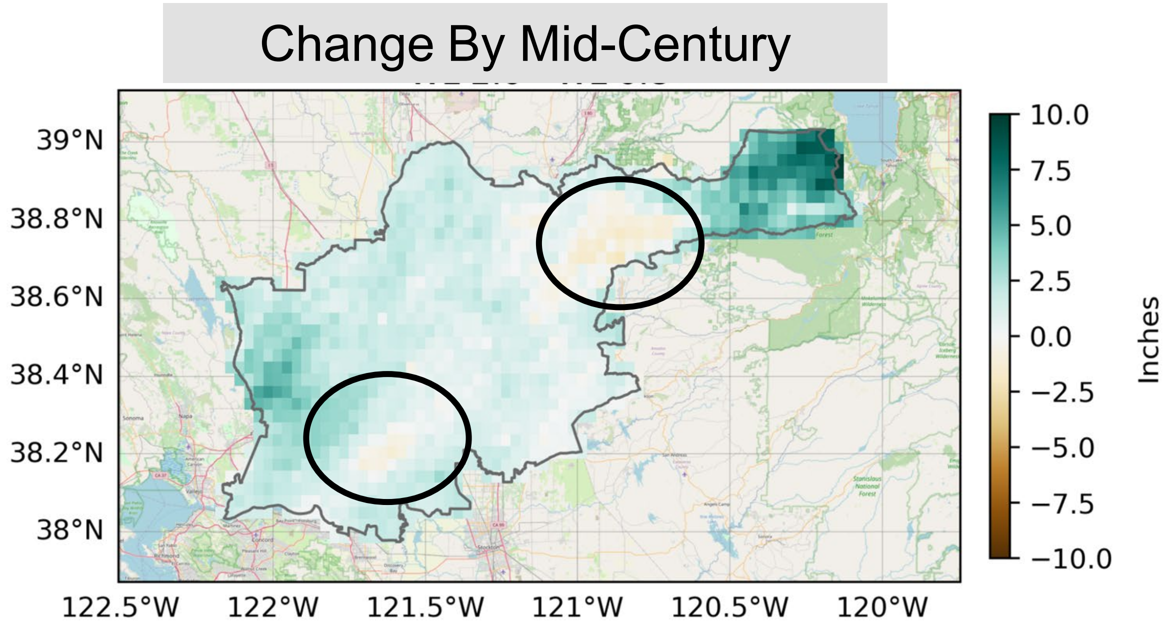
Dry

Change By Mid-Century

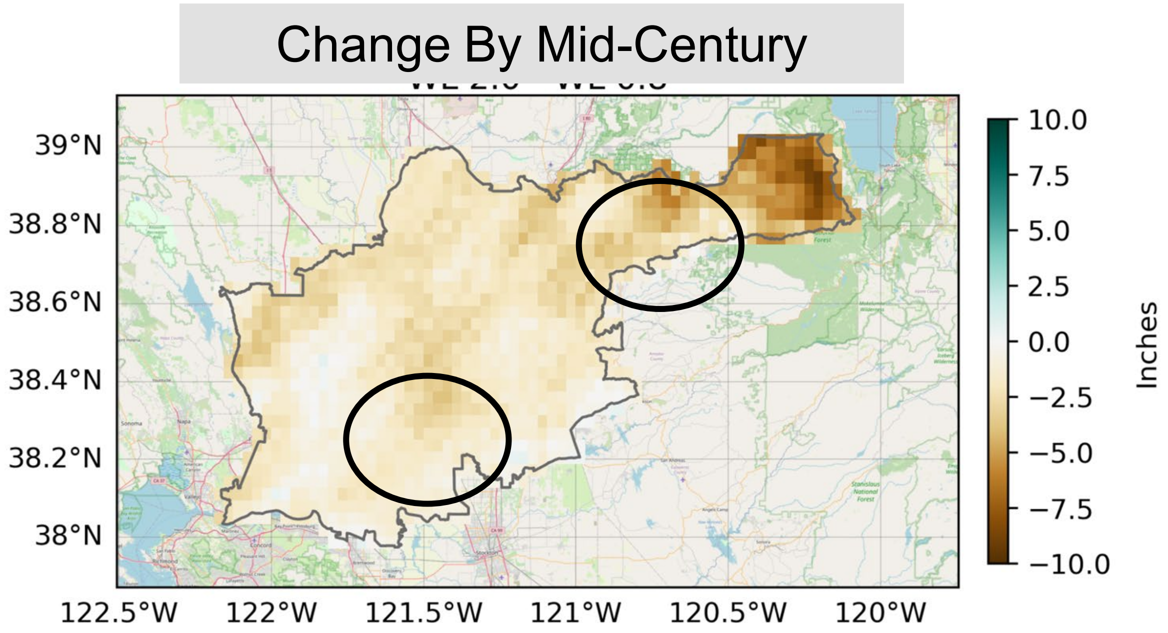


Extreme Precipitation

Wet



Dry



Impacts

- Change in number of wet and dry days is modest
  - This suggests a similar number of storm events per year
  - But the amount of precipitation with each storm will change

- In a wet future the number of extreme heavy precipitation days increase
  - Increases focused across UARP

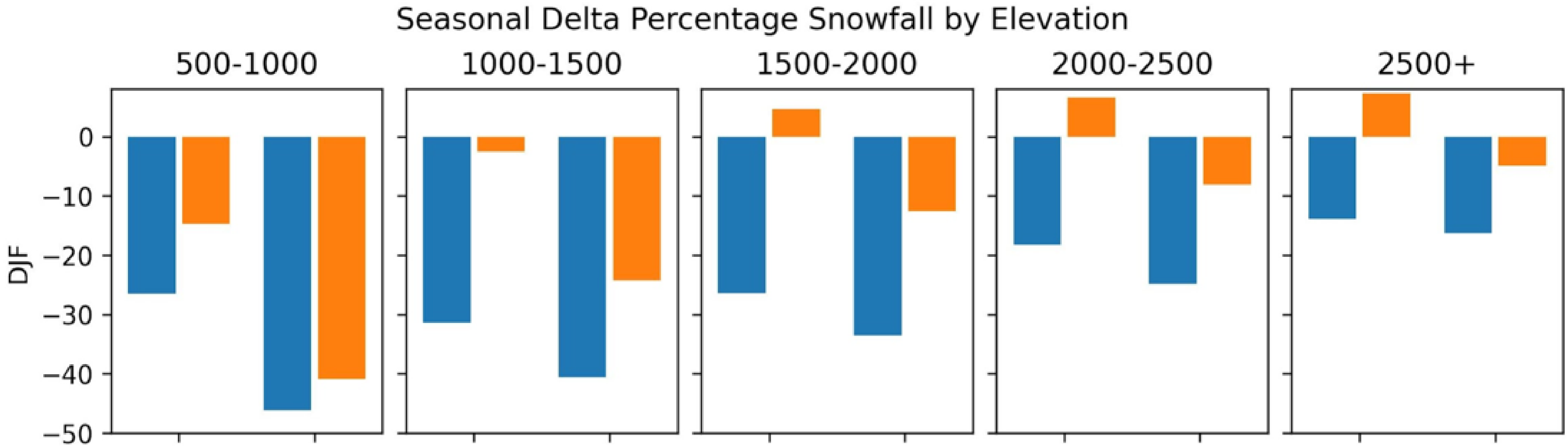
- For the dry future the number of extreme heavy precipitation days decreases
  - Decline focused accross UARP

- Changes in extreme precipitation seem to drive the changes in total precipitation in UARP

Key Finding: Snowfall

EAGLE ROCK ANALYTICS

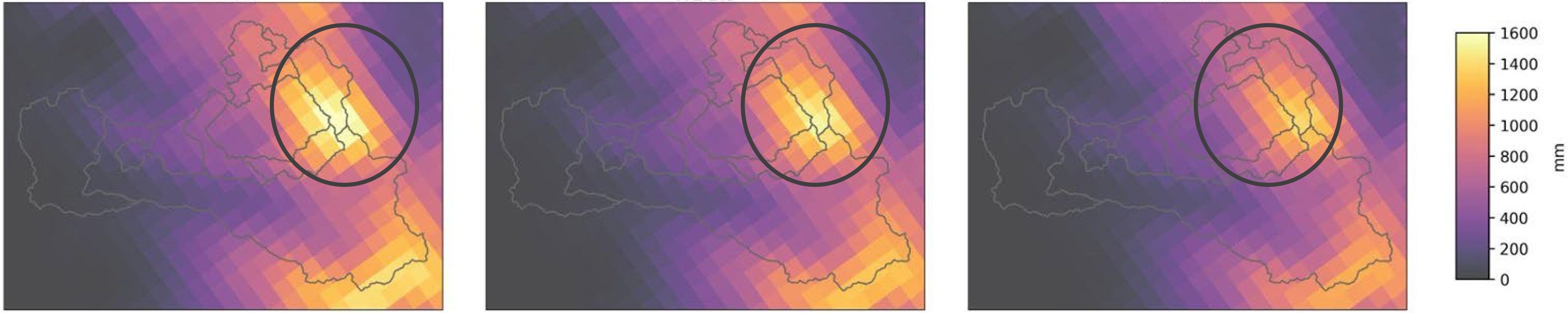
Change In Snowfall Varies by Elevation



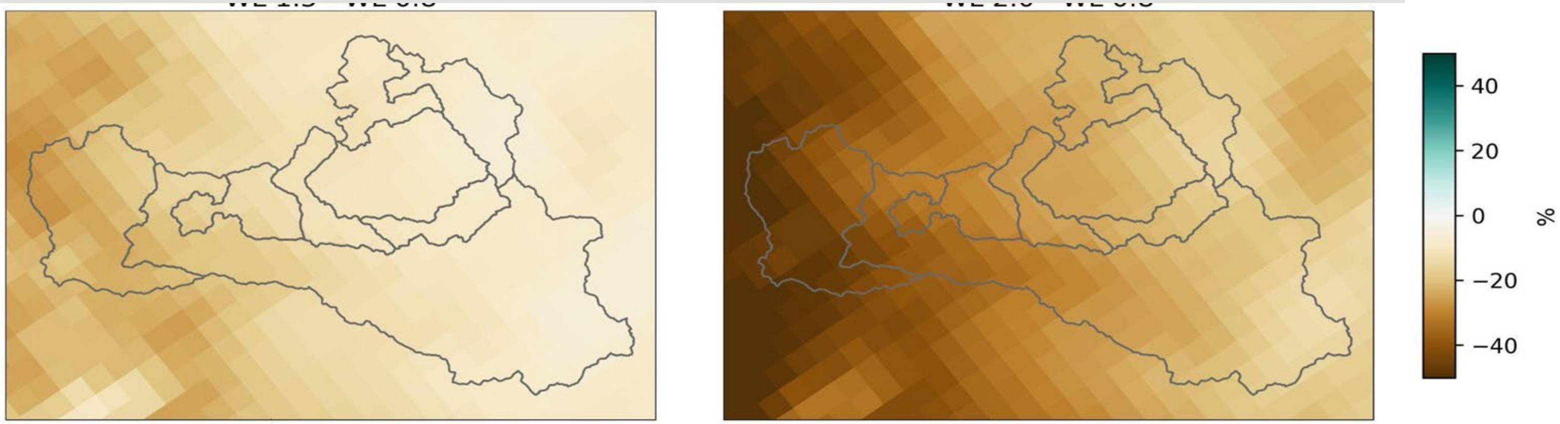
analytics.cal-adapt.org/

Annual Snowfall

Recent Century | Next 10 Years | Mid-Century

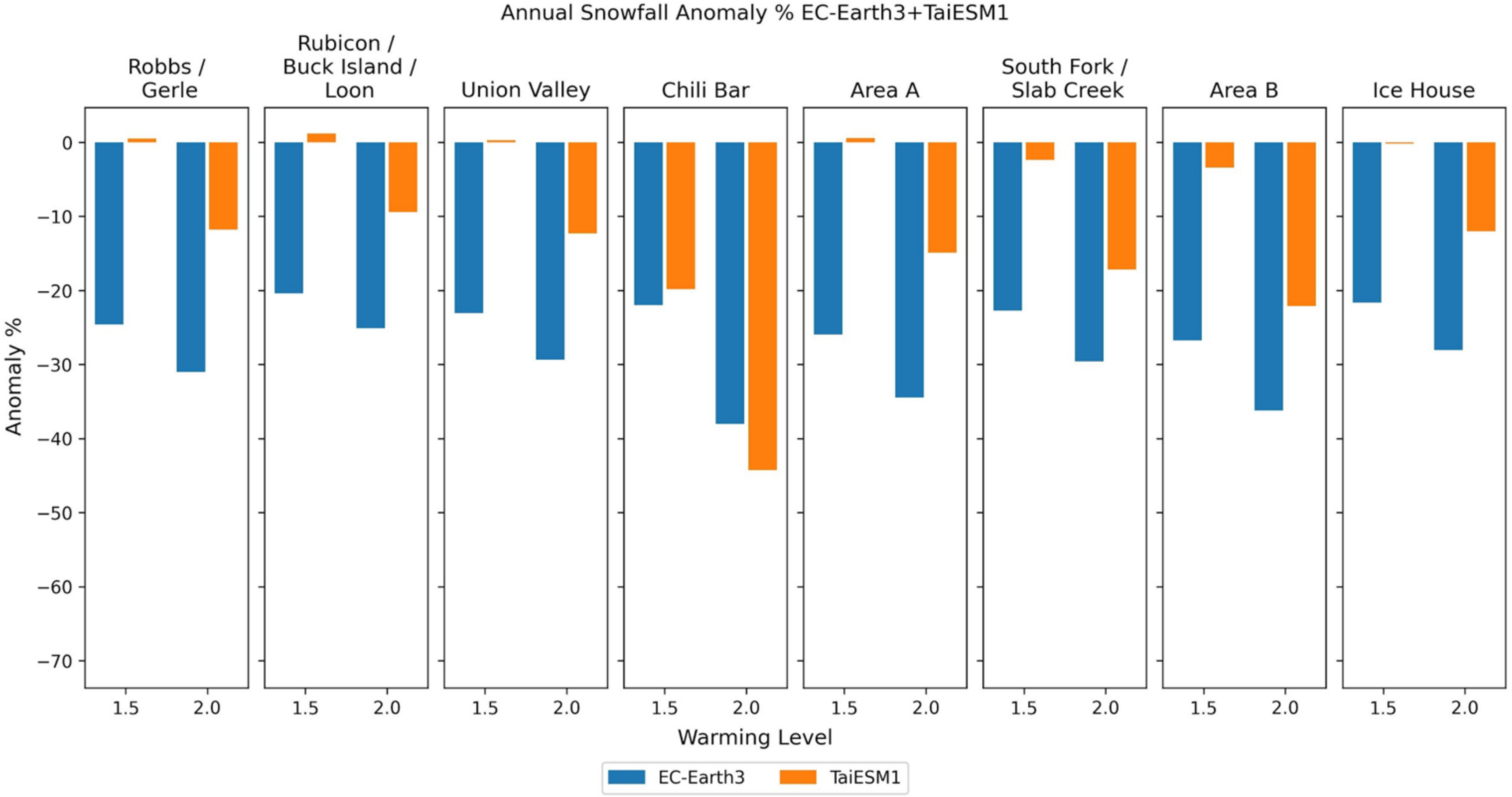


Change Next 10 Years | Change By Mid-Century



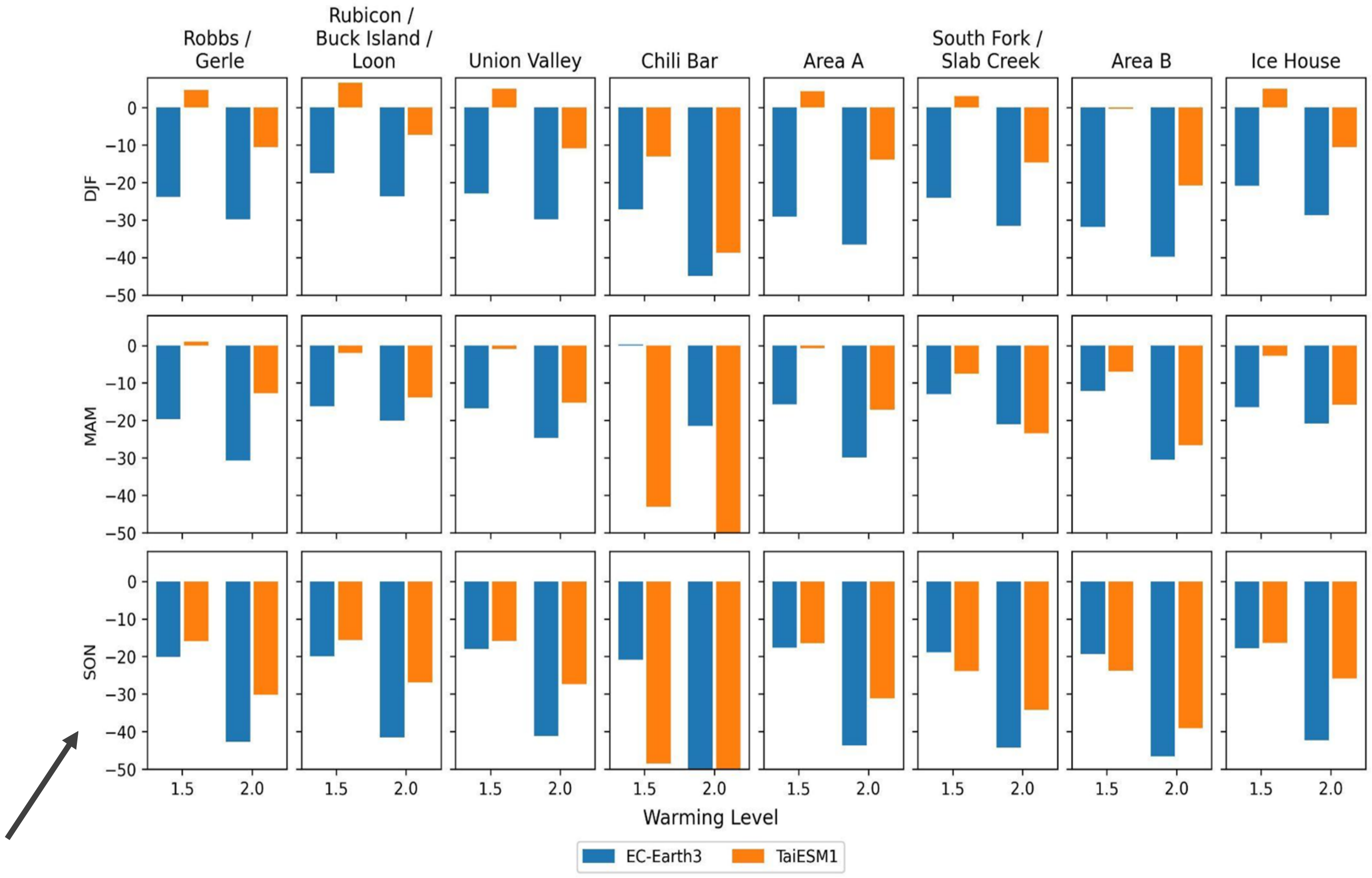
Annual Snowfall by Basin

- **High confidence** that annual snowfall will decrease across each basin by 10-20% by 2.0º warming
- Chili Bar will see the largest decrease in snowfall (at least a 35% decrease) under 2.0º warming



Seasonal Snowfall by Basin

- **High confidence** in a 30-40% decreases in snowfall occurring in SON across all basins under 2.0º warming
- **High confidence** in a 10-20% decrease in snowfall during MAM under 2.0ºC warming



Good consistency between the two models during SON

Impacts

- Reductions in snowfall are anticipated across the UARP
  - Reductions occur regardless of “wet” or “dry” future
  - All SMUD reservoirs will see reductions in snowmelt

- The largest reduction in snowfall will occur at lowest elevations
  - Different SMUD reservoirs will see different amounts of snowmelt
  - Lowest elevation basins will see the largest declines in snow

- Reductions in snowfall are not uniform across the year
  - Spring and fall seasons will see the largest decline in snow
  - A modest increase in snowfall is possible in winter at highest elevations

- Fall snowfall declines are anticipated to be the biggest reductions
  - Different SMUD reservoirs will see different amounts of snowmelt
  - Lowest elevation basins will see the largest declines in snow

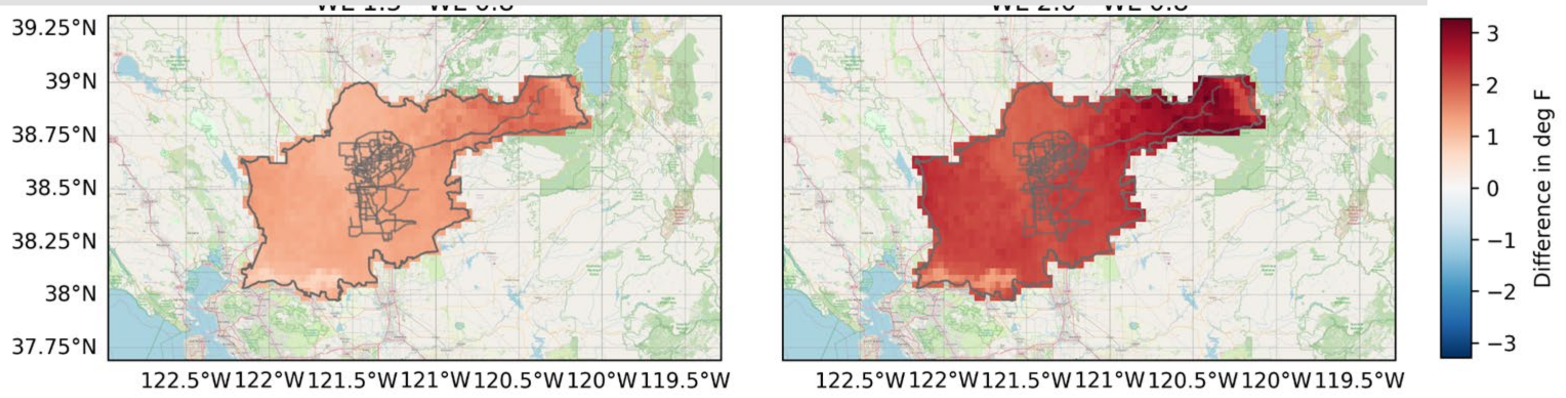
Other Key Findings

EAGLE ROCK ANALYTICS

Wildfire Risk

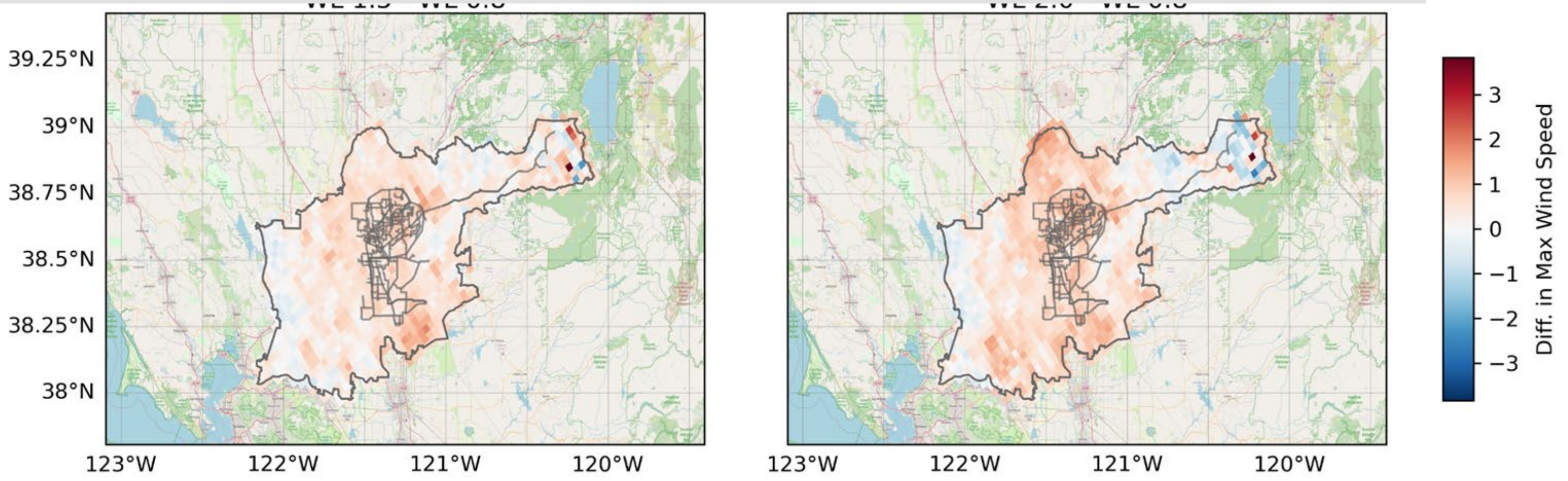
Heat

Change Next 10 Years	Change By Mid-Century



Extreme Wind

Change Next 10 Years	Change By Mid-Century



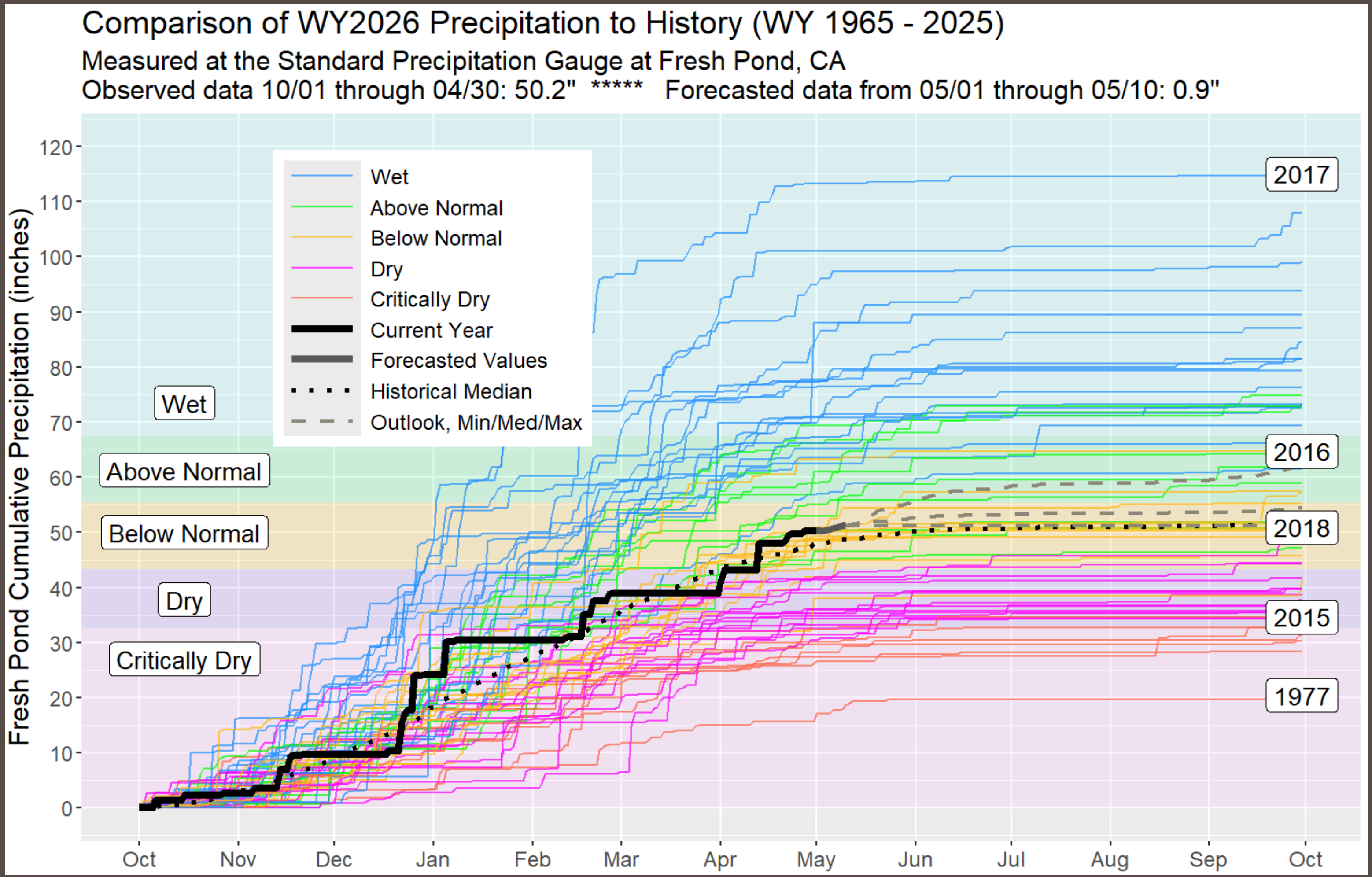
Key Takeaways

1. Expect changes in when in seasons precipitation occurs
2. The number of days with precipitation will not change, but the amount of precipitation will
3. The snowpack will be reduced, particularly at lower elevations
4. The reduction in snowpack is not uniform across the year, but rather focused on fall and spring season snowpack
5. Changes in precipitation, temperature and wind may impact wildfire risk across UARP

Christine Giannini

Manager, Resource Optimization (SMUD)

Variability in the UARP



Managing variability is a core competency of hydro operations. Shifting climate conditions amplify this inherent variability increasing complexity across four key operational dimensions:

- Interannual variability
- Intra-annual variability
- Precipitation type variability
- System & constraint variability

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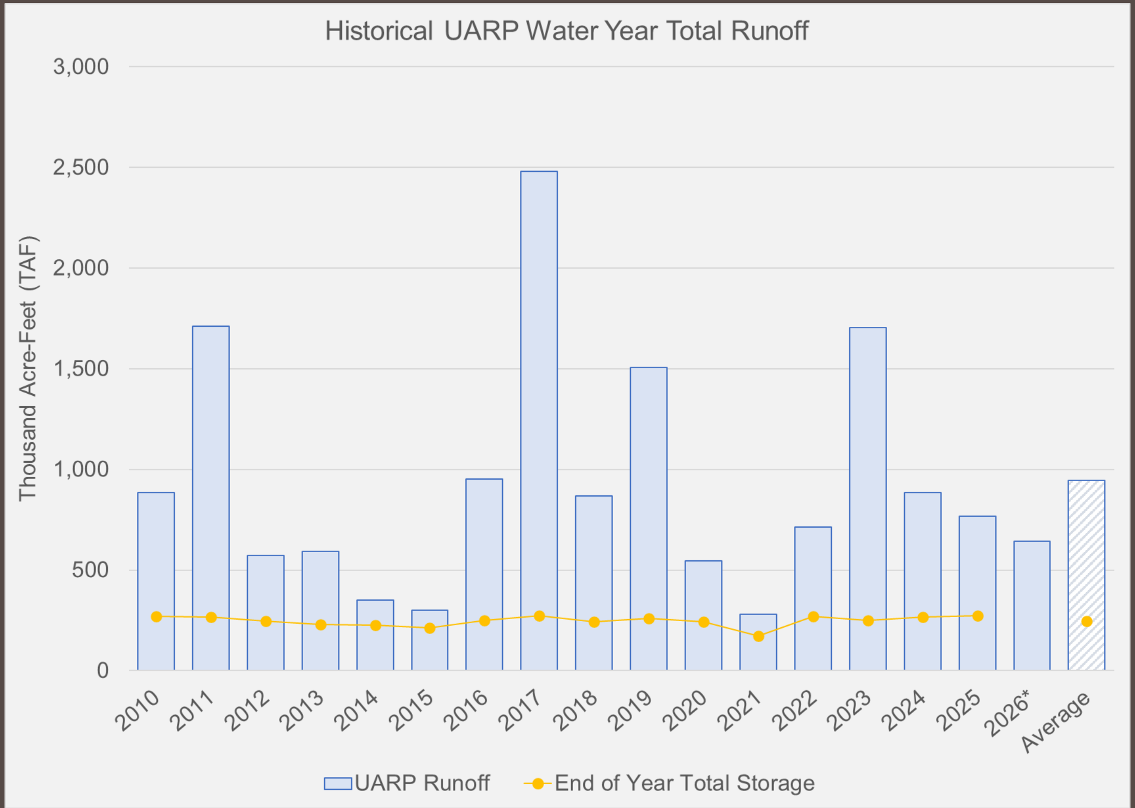
Interannual Variability – How Much

Operations must be managed reliably across all types of water years.



Type of interannual variability:

- Wet vs. Dry Years
- Drought Sequences vs. Back-to-Back Wet Years
- Total Inflow Fluctuations

How this impacts operations:

- End of Water Year storage decisions
- Long-Range planning becomes a necessity
- Risk tolerance, storage decisions for reliable operations

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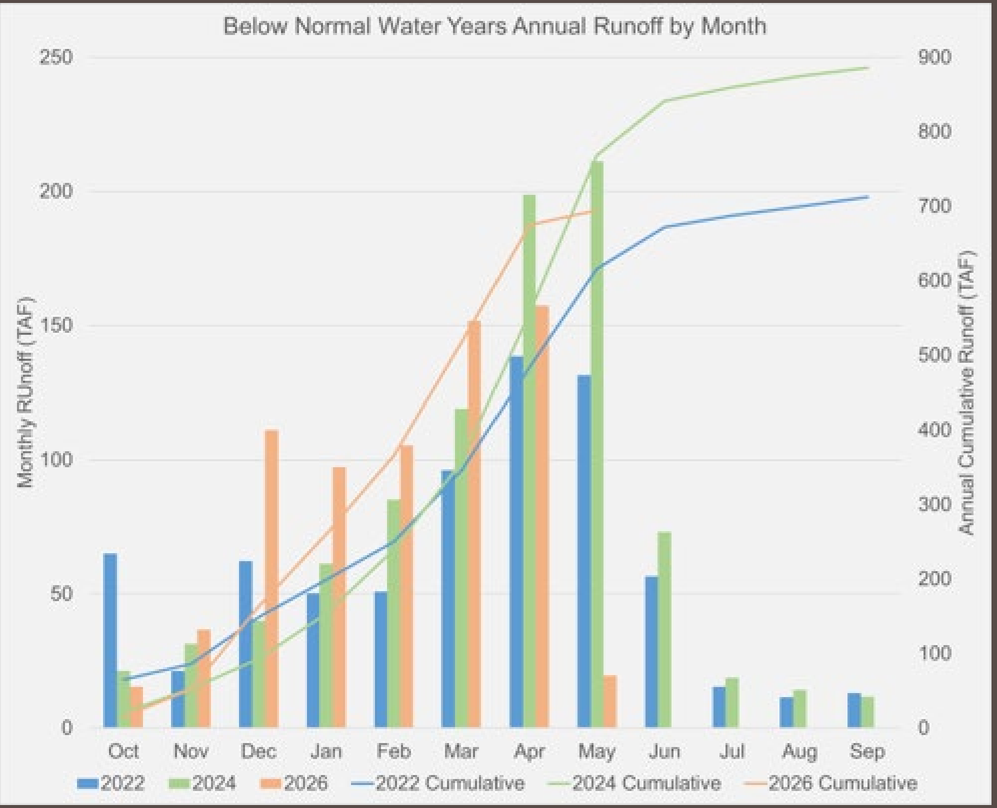
Intra-Annual Variability – When (Seasonal & Event Driven)

It's not just about how much water we get – it's when we get it.



Types of intra-annual variability:

- Timing of runoff, early versus late
- Storm Clustering vs. Spaced Events

How this impacts operations:

- Dependence on short-term forecasts
- Rapid and flexible operations adjustments

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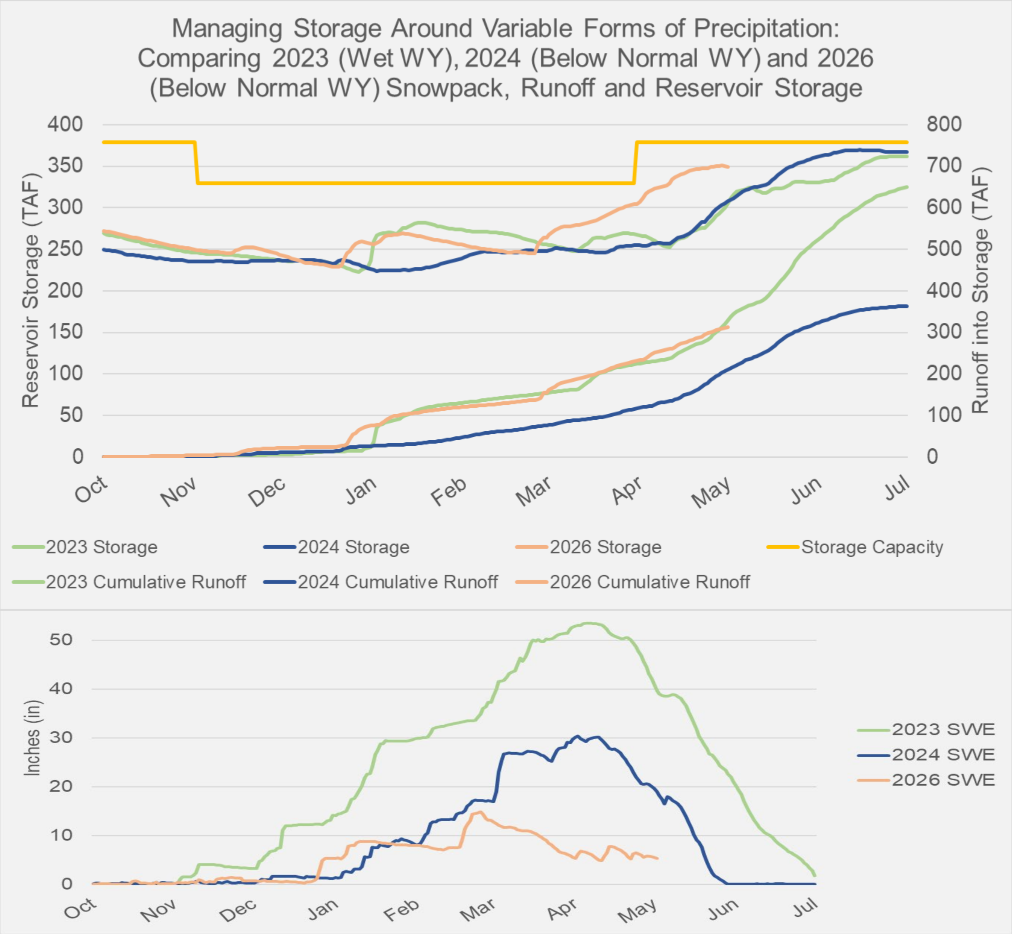
Precipitation Variability – What Form (Snow vs. Rain)

Snowpack is our largest reservoir - the volume whether low or high can swing operations dramatically.



Types of precipitation variability:

- Snowpack (natural storage) vs. rainfall (immediate runoff)

How this impacts operations:

- Snowpack generally predictable in slower-release and timing
- Rain-on-snow events accelerates snowpack decline
- Rainfall impacts real-time with limited opportunity for adjustments around forecast uncertainty

System & Constraint Variability – Always Present

Hydro operations balances competing objectives – not a single objective. Every operational decision is a trade off.

Types of system constraints:

- Safety consideration for technicians & community
- FERC License Requirements (ecological, environmental, recreational)
- Physical limitations (generator capacity, outages, tunnels and canals)
- Market conditions (negative pricing)

How this impacts operations:

- Reliance on imperfect forecasts
- Providing water for reliability operations
- Cascading system dispatch coupled with reservoir inflows

The Bottom Line for SMUD Hydro Operations

Hydro systems are built to manage variability.

Climate change is increasing both the range and speed of the variability.

This raises operational complexity, risk and the need for flexibility across the system.

UARP Long Range Plan Evaluations

Josh Langdon
Dir. Power Generation

Long Range Plan Evaluations (>10 yrs)

- Overall System Management Opportunities
  - Vegetation and forest management (wildfire risk reduction and water retention)

- Minimizing the impact of seasonal Variability
  - Strategic Partnerships and Collaboration
    - Climate resilient forecasting framework
    - Union Valley (UV) Additional Outlet – Evaluating additional powerhouse and Junction to UV Pump storage
    - Evaluate Capacity Improvement Opportunities
      - Feasibility Study to Raise UV Dam
  - FERC Reservoir Management – Abnormal Precipitation Patterns
  - Continue to Strengthen Partnerships and Improve Modeling and Communications

Additional Research Questions

- Can the combination of Forecast Informed Reservoir Operations (FIRO) and Union Valley outlet and dam investments increase generation enough to offset losses due to reduced snowpack and increased variability in precipitation patterns?
- How will extreme storms and wind exposure increase specific UARP asset vulnerability over time, and how can that vulnerability be mitigated?
- To what extent will changing forest composition and biological disease agents (including beetles) due to warming temperatures increase system asset risk and operational/maintenance costs? How will those trends impact forest carbon storage and sequestration?
- Do we have weather blind spots in the UARP? Assess weather station locations to ensure data covers all critical assets

Questions?