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UC San Diego

Extreme Weather Events in the Changing Climate of California

Center for Western Weather and Water Extremes

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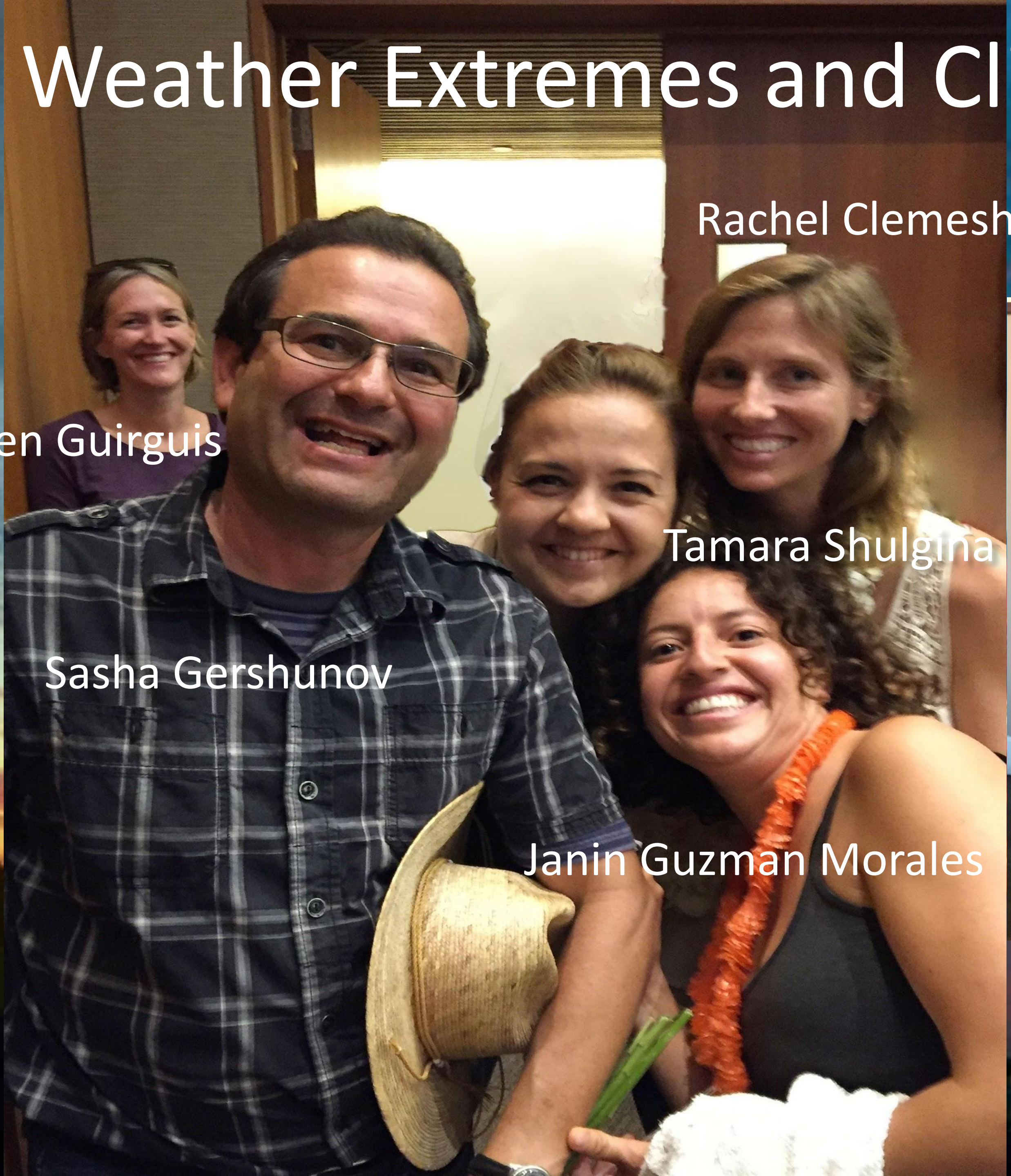
CNAP California-Nevada Climate Applications Program A NOAA RISA team

DEPARTMENT OF THE INTERIOR U.S. BUREAU OF RECLAMATION

DEPARTMENT OF WATER RESOURCES STATE OF CALIFORNIA

Weather Extremes and Climate Impacts Analytics (weclima.ucsd.edu)



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Weather Extremes
in a Varying and Changing Climate

WECLIMA

Weather Extremes and Climate Impacts Analytics

weclima.ucsd.edu

Precipitation Regimes and Extremes

Heat Waves and Cold Spells

Marine Layer Clouds

Santa Ana Winds

Fire Weather

Atmospheric Rivers

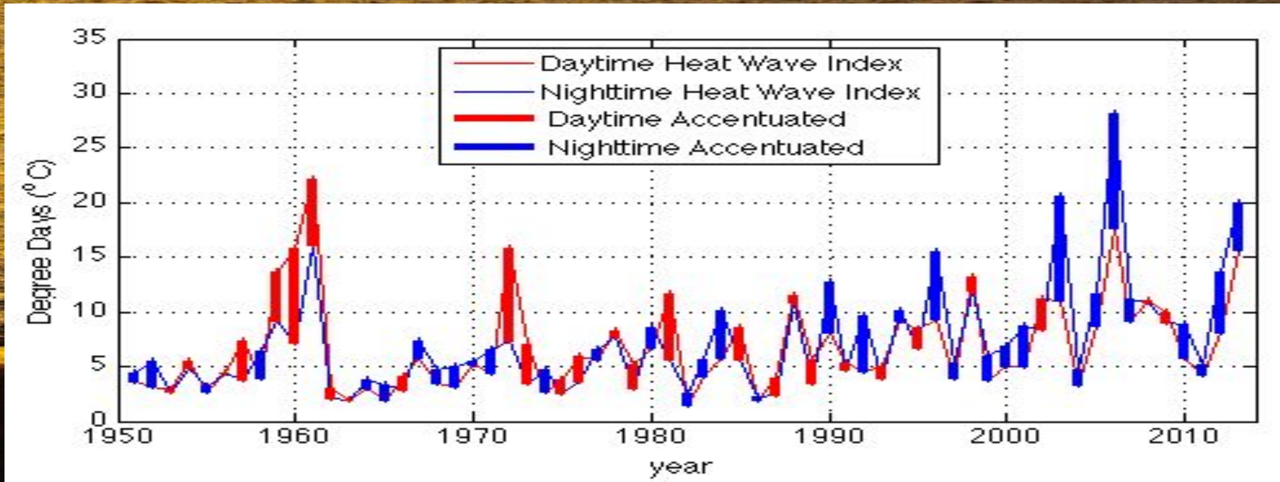
Droughts and Floods

IMPACTS ON SOCIETY

Heat Waves

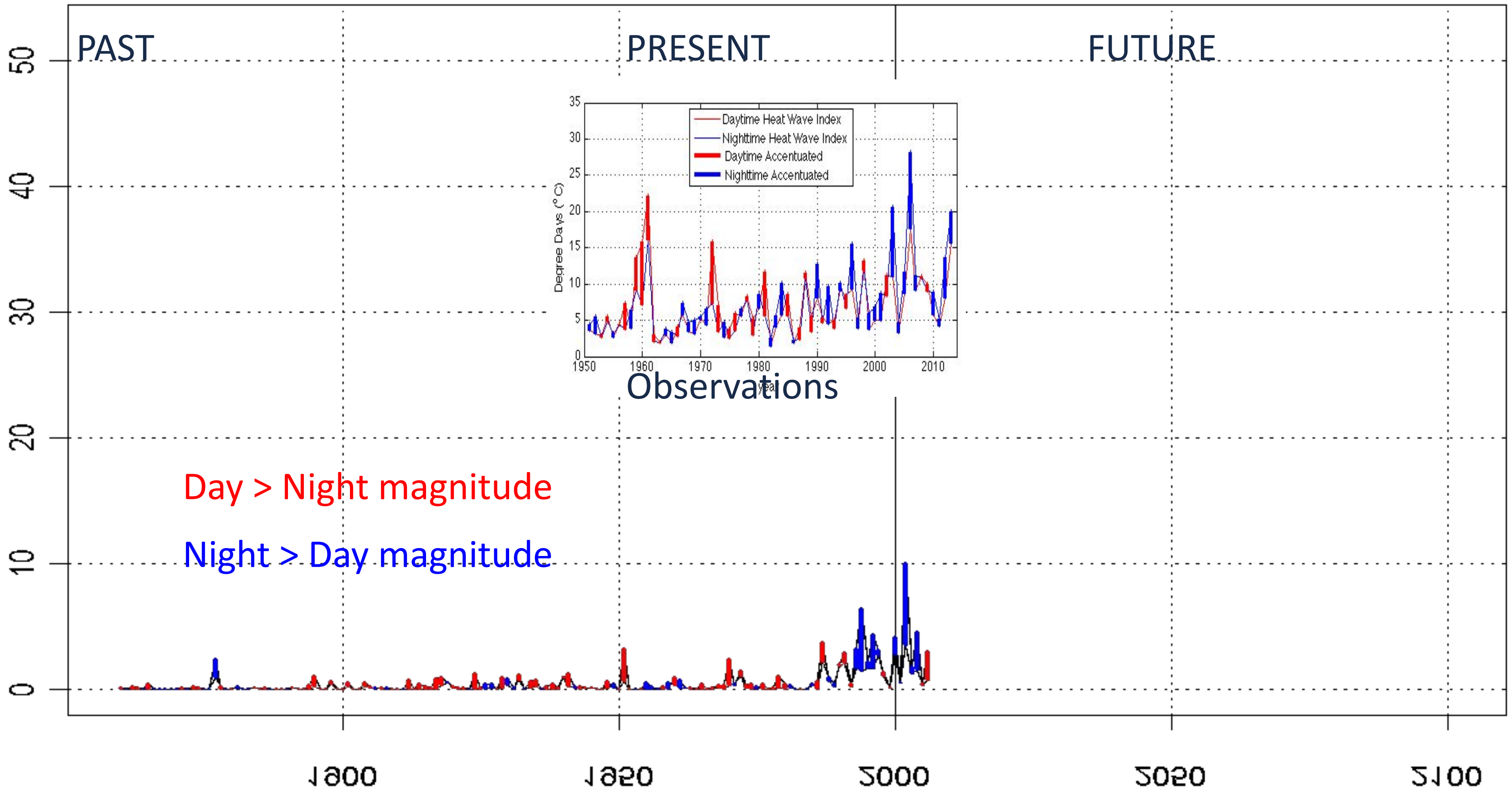
With Kristen Guirguis

Observed Heat wave index for California



California Heat Waves and Climate Change

A vetted **climate model** under a **mild emissions scenario**

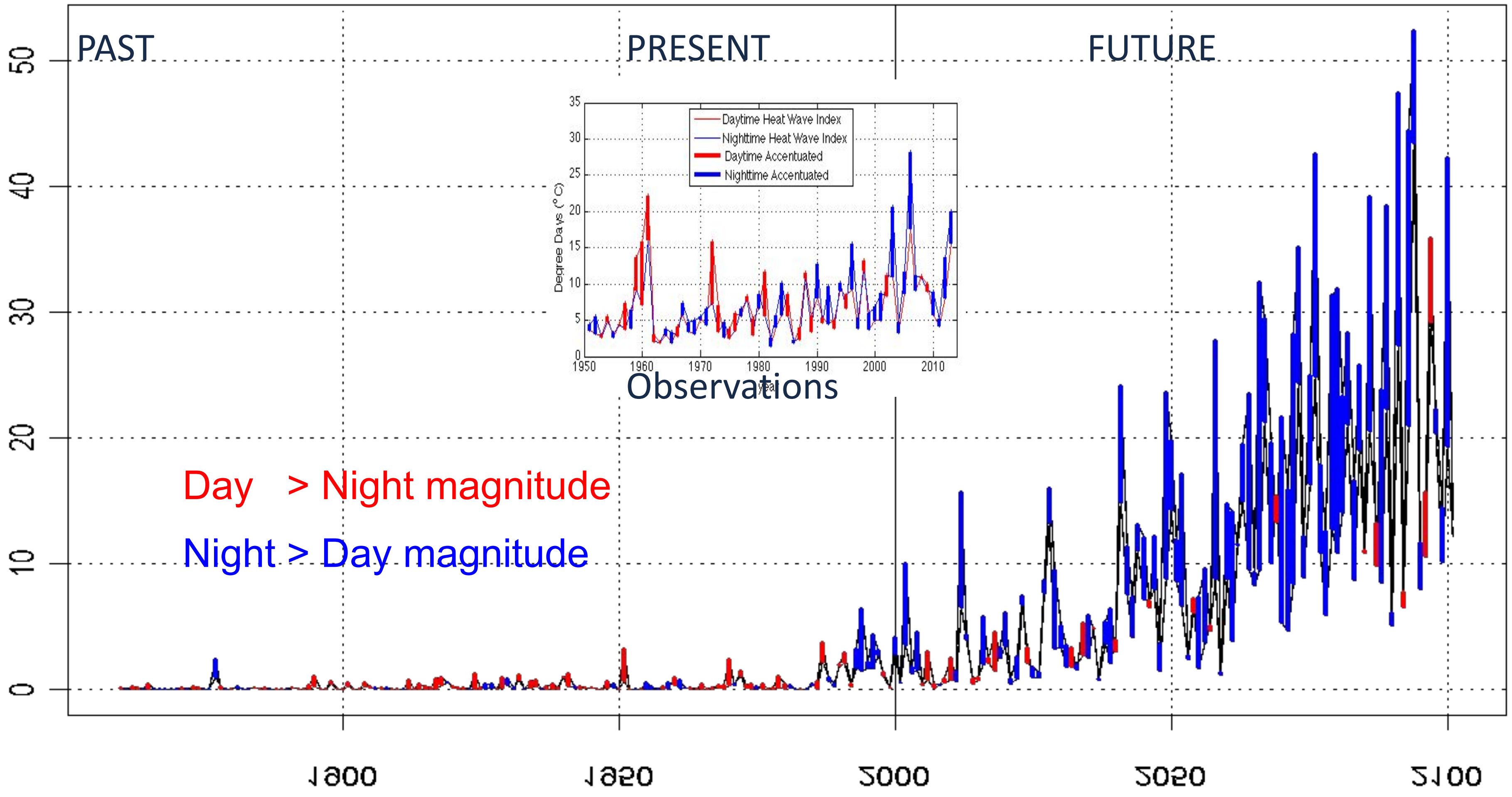


CNRM Global Climate Model

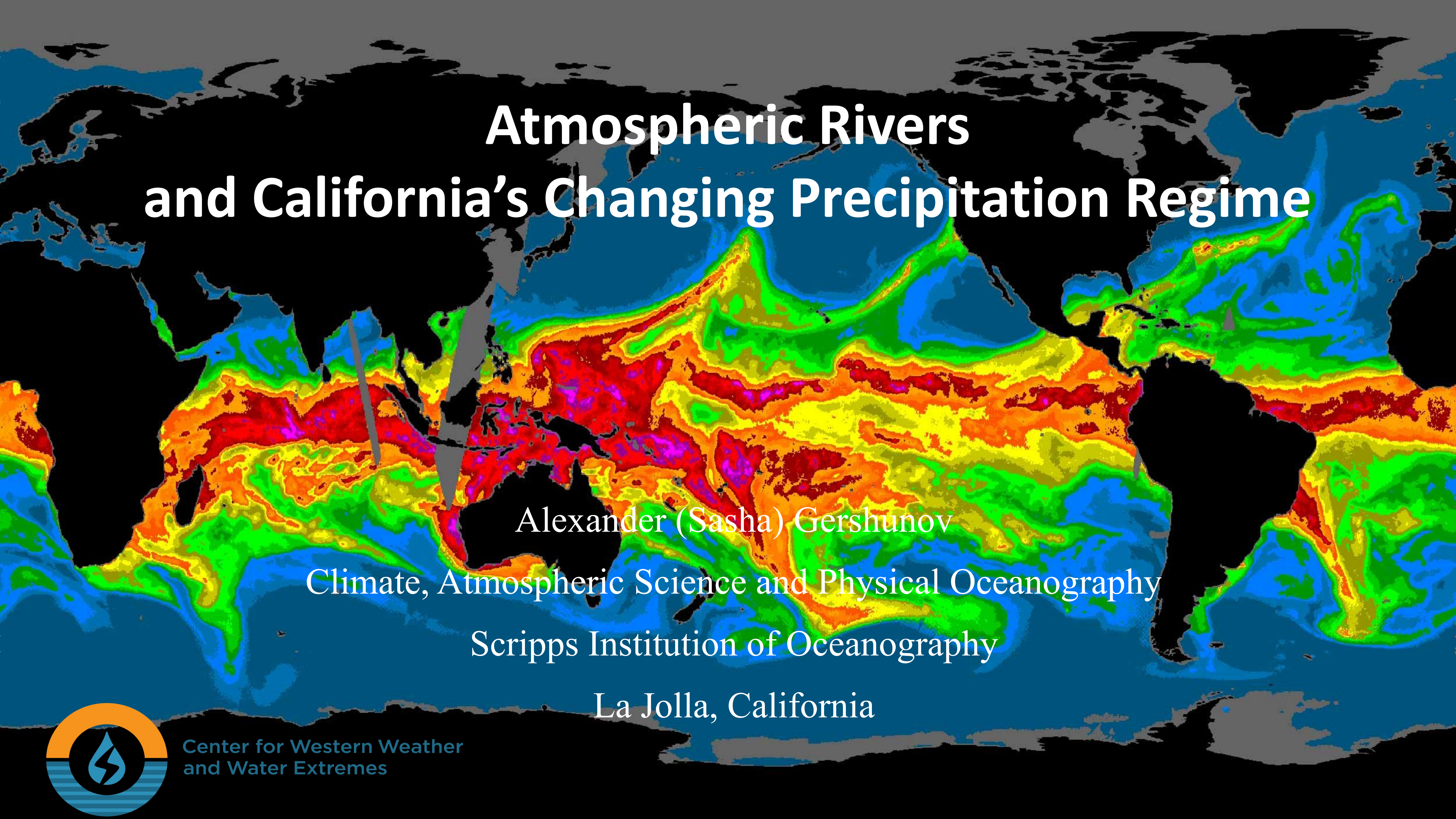
California Heat Waves and Climate Change

A vetted **climate model** under a **mild emissions scenario** suggests that the observed change is a tip of the iceberg.

HEAT WAVES ON STEROIDS



CNRM Global Climate Model



Atmospheric Rivers and California's Changing Precipitation Regime

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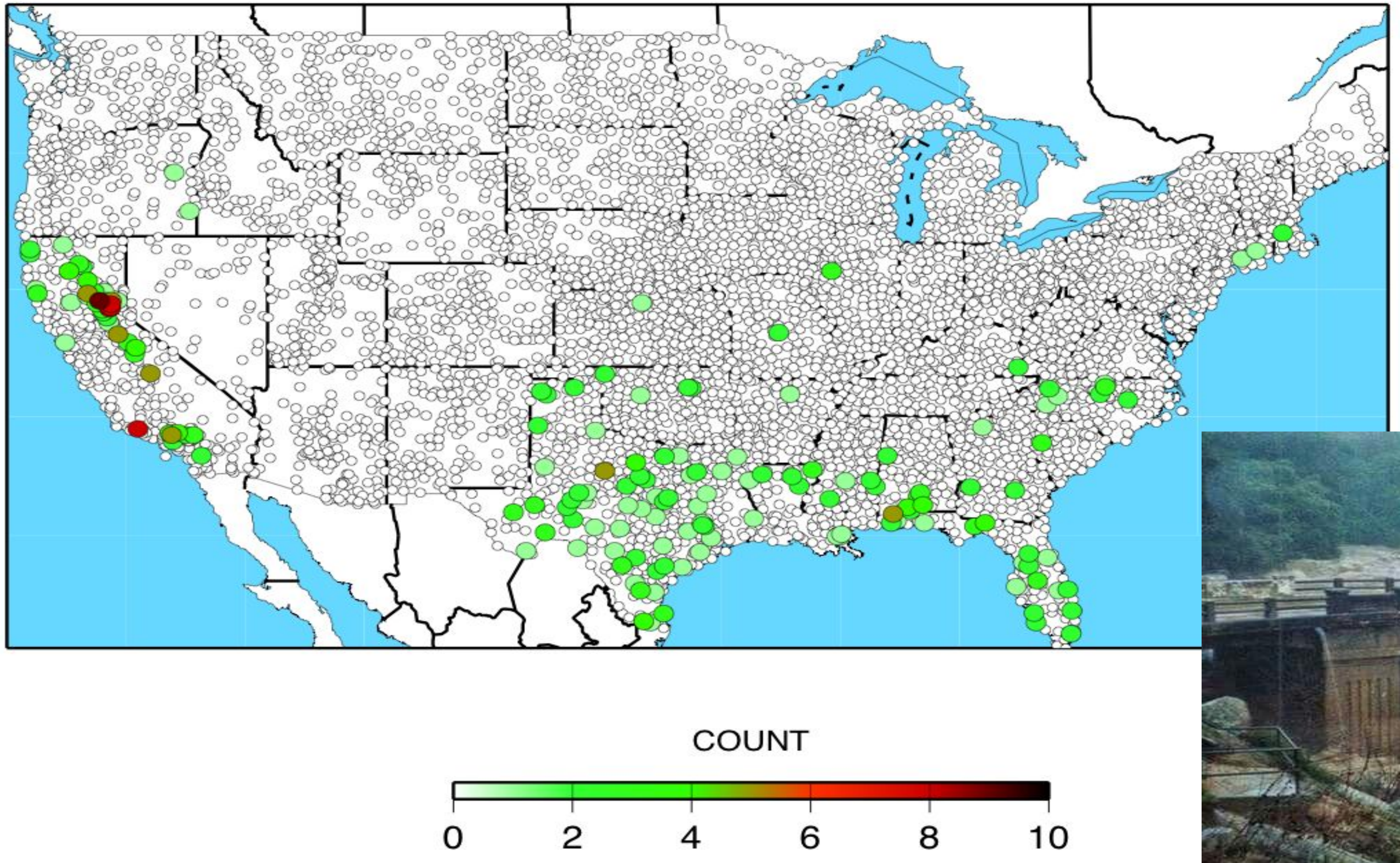
California's Wild Precipitation

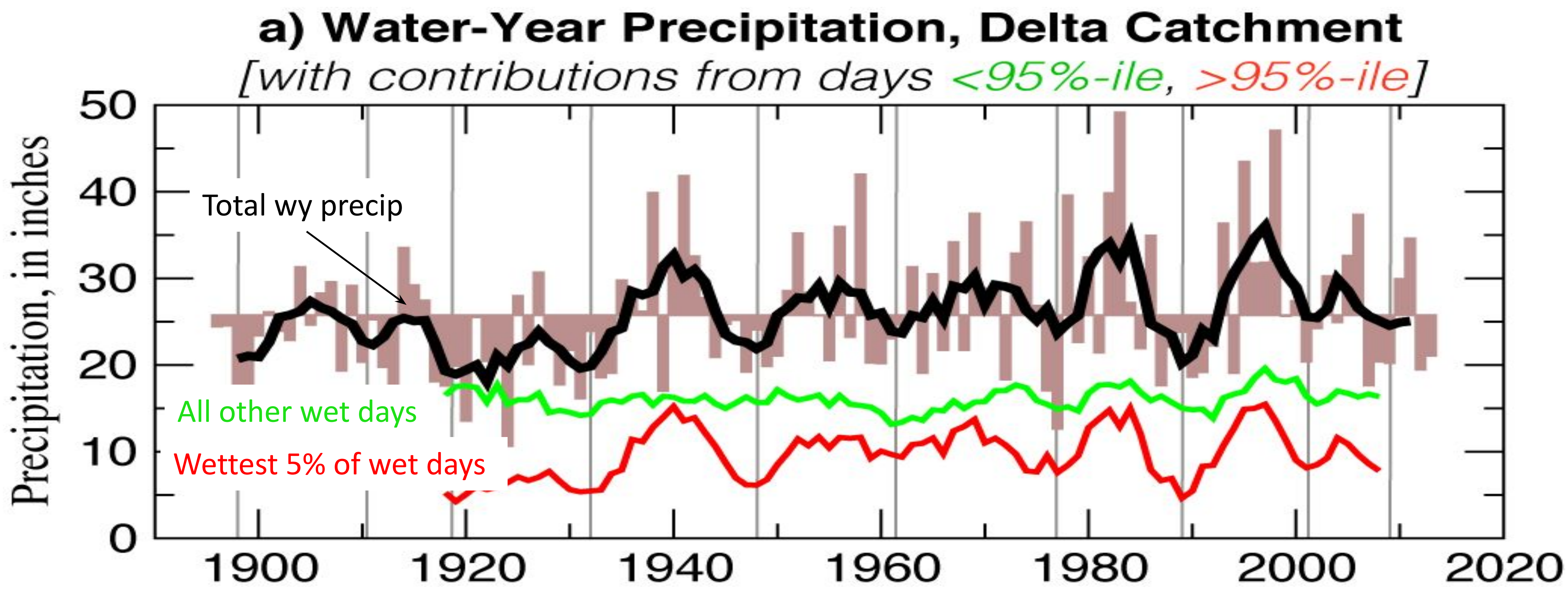
Three-day episodes with > 40 cm (15 in) precipitation since 1950



Dettinger et al, Water, 2011

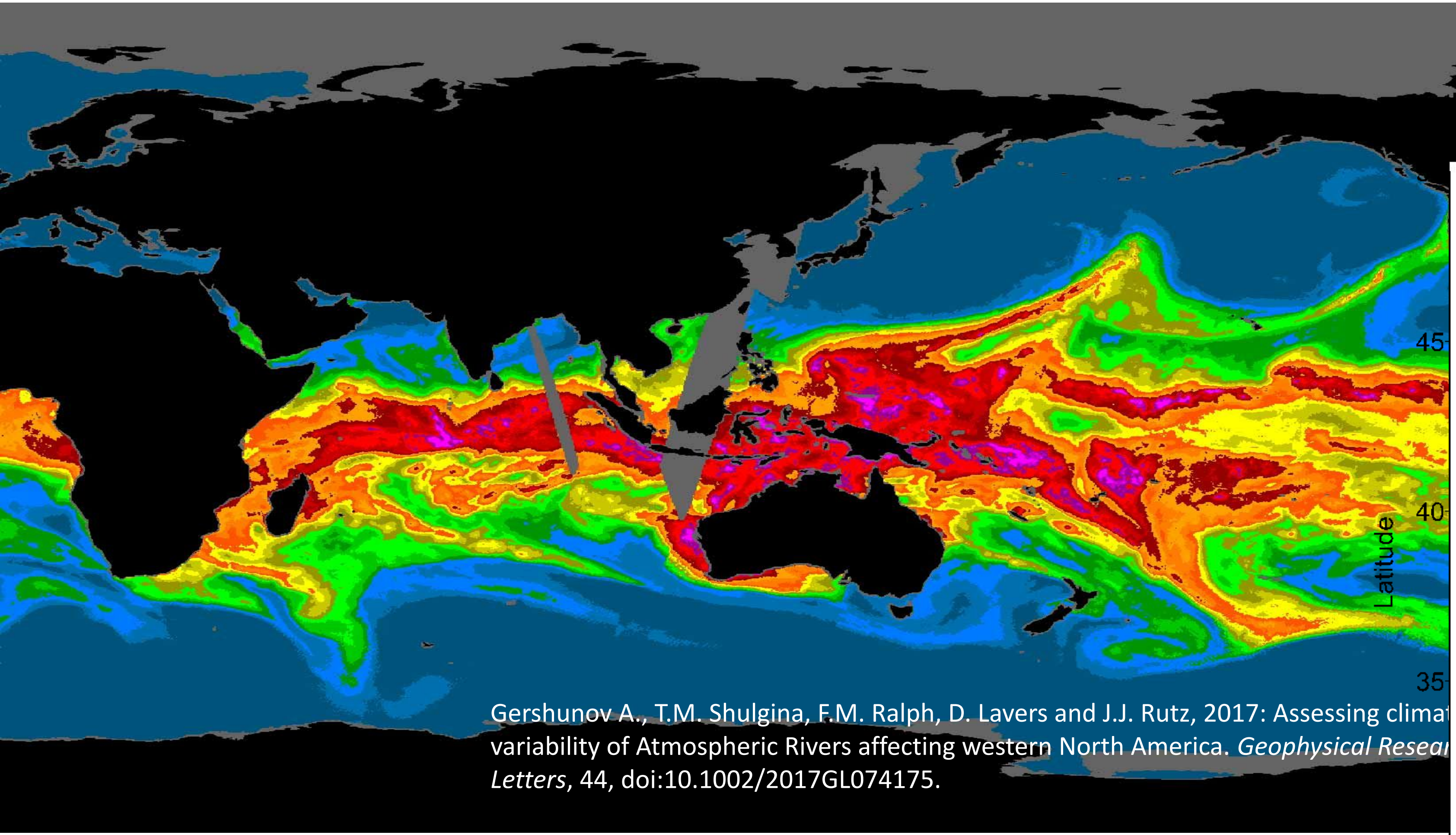
California's BIG storms are as big as any in the country!

California's floods & droughts are uniquely tied to each other

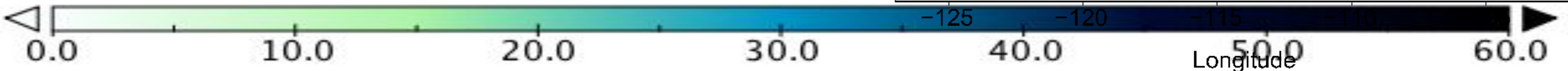


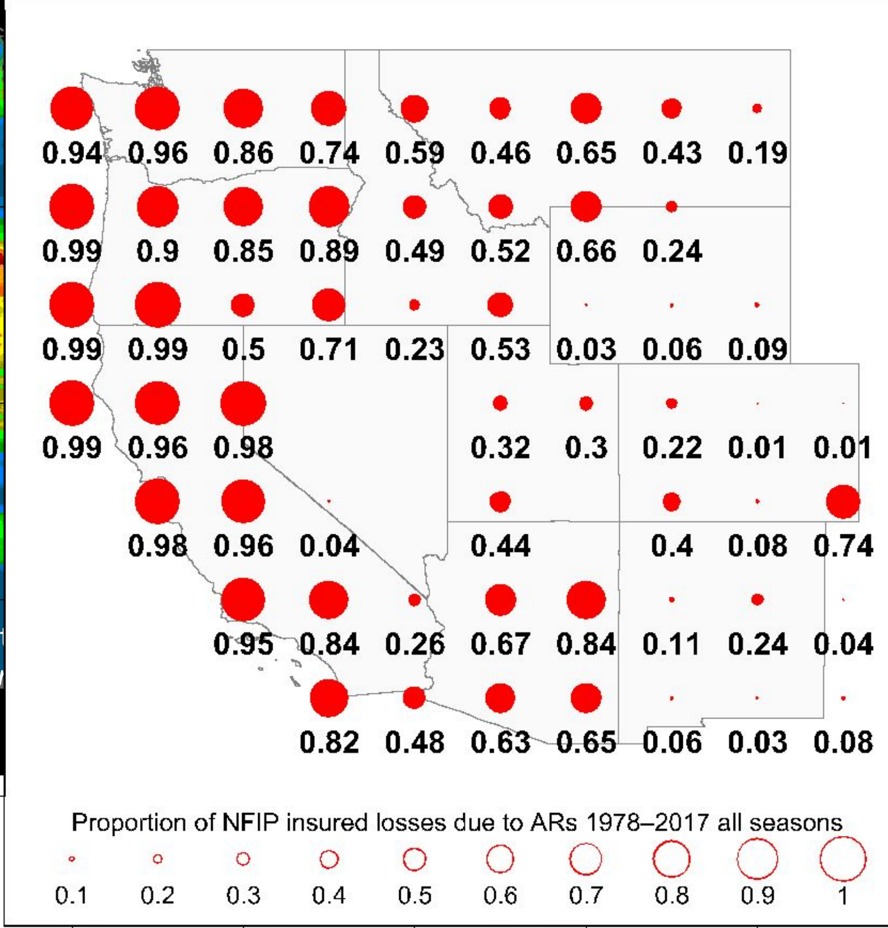
Dettinger & Cayan, SFEWS, 2014; Dettinger, SFEWS, 2016

Atmospheric Rivers



ATMOSPHERIC WATER VAPOR





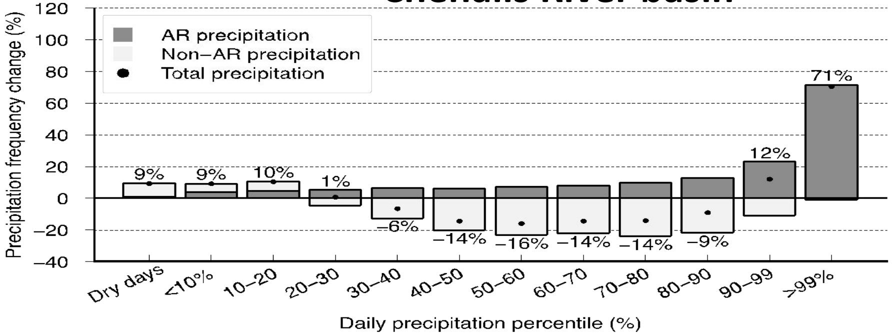
Corringham et al., *Science Advances* 2019

Change (%) in precipitation frequency by intensity bins (LOCA, 5 GCM average):

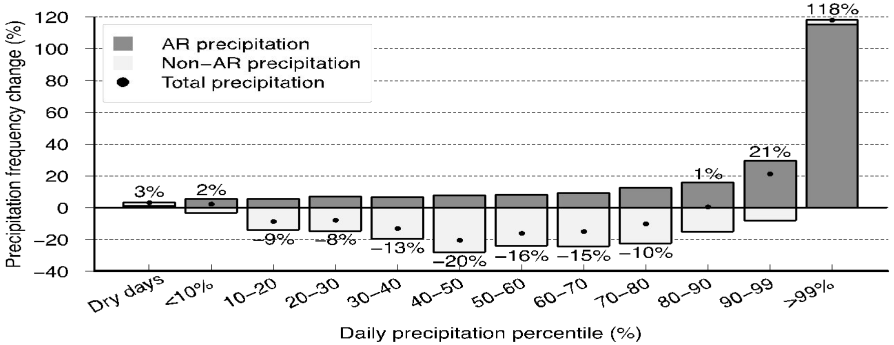
[EXTREME PRECIP INCREASING DUE TO ARs]()

(PRECIP DISTRIBUTION SHIFTING TO MORE EXTREME VALUES DUE TO ATMOSPHERIC RIVERS)

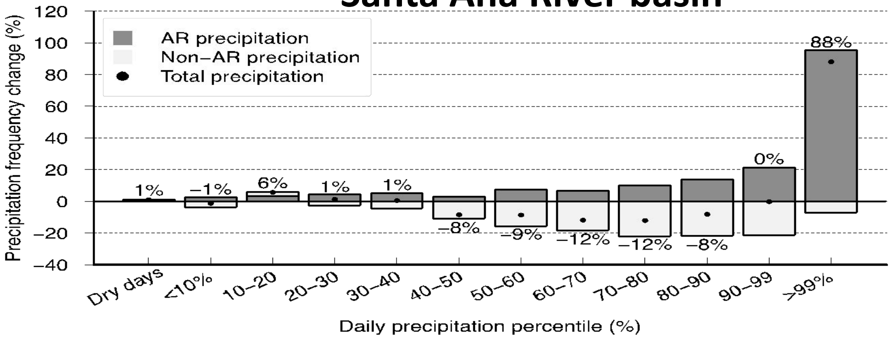
Chehalis River basin



Russian River basin

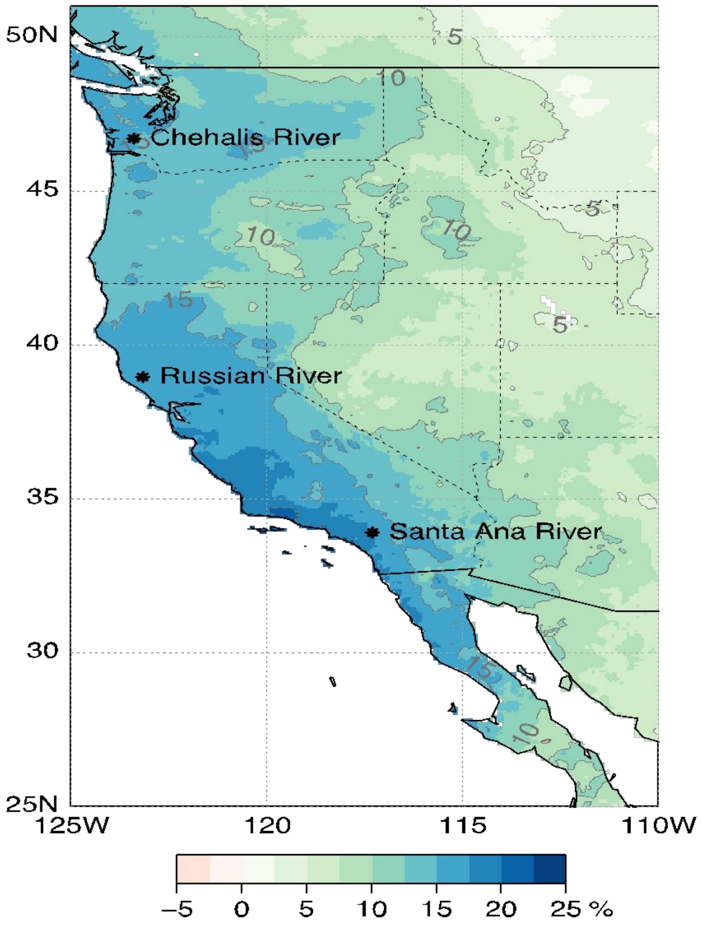


Santa Ana River basin



Historical intensity bins

Change (%) in AR contribution to total annual precipitation:



Atmospheric Rivers are poised to play a bigger role in a warmer future

- Providing heavier precipitation in drier times "Flood during drought"
- Thermodynamics boost ARs (ARs on steroids)
- Hazardous/beneficial AR ratio may be expected to change?
- **More variability of water resources from year to year**
- Bigger challenges for
  - Water resource management
  - Weather and climate forecasting
  - Snowpack accumulation and retention
  - Water quality
  - Wildfire management and related impacts
  - Etc.
- **Skillful prediction of ARs (all timescales and lead-times) becomes even more important**

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Atmospheric Rivers are already playing a bigger role in a warmer present!

- **Recent ARs are already boosted by the steroids of climate change!**
  - Oroville Dam near disaster, February 2017
  - Return periods of extreme precipitation events

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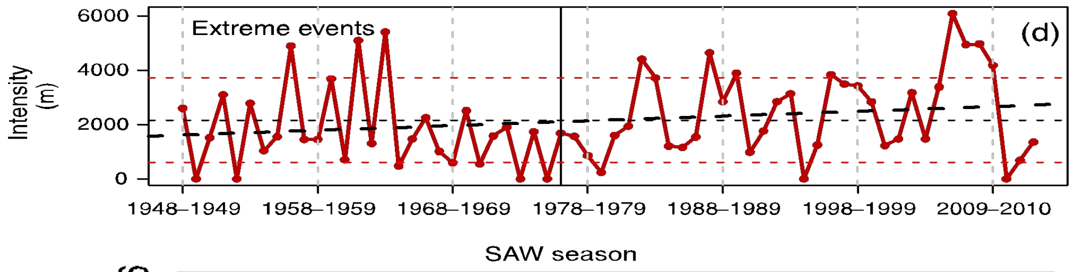
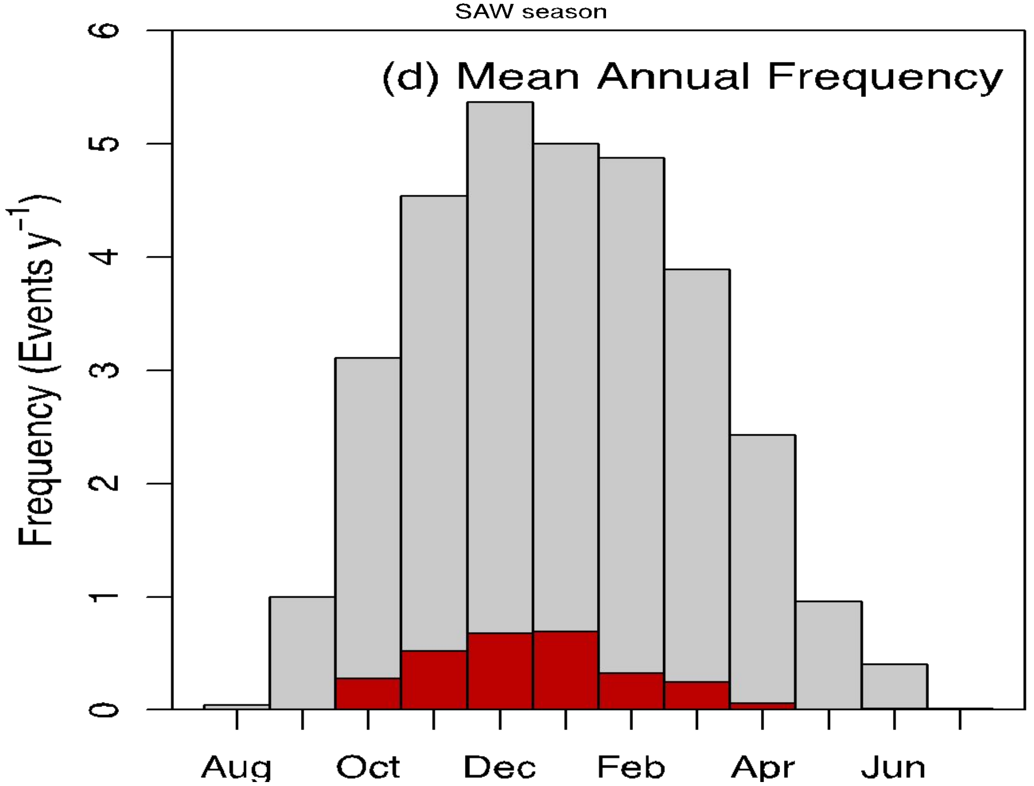
Santa Ana Winds

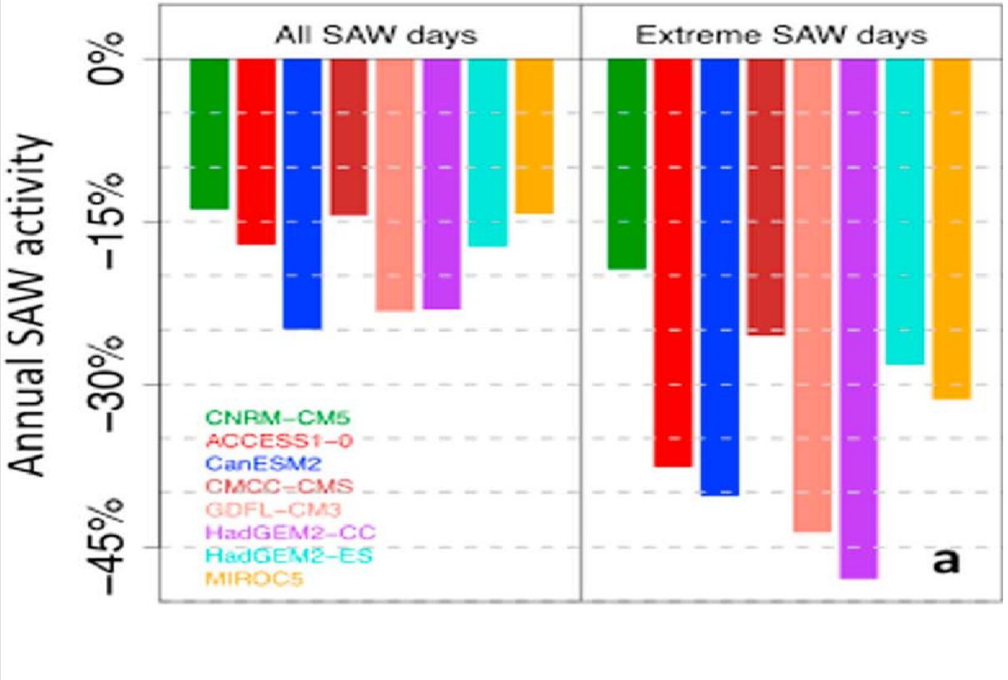
With Janin
Guzman Morales





Guzman Morales, J., A. Gershunov, J. Theiss, H. Li and D. Cayan, 2016: Santa Ana Winds of southern California: their climatology, extremes and behavior since 1948. *Geophysical Research Letters*, 43, doi:10.1002/2016GL067887.

Santa Ana Winds



Projected percentage change of the SAW run seasonality. Thick black line shows the global climate model ensemble mean and gray envelopes delineate ±1 standard deviation. Thick red line corresponds to the all global climate models mean change of extreme SAWs.

Guzman Morales, J. and A. Gershunov, 2019: Climate change suppresses Santa Ana Winds of Southern California and sharpens their seasonality. *Geophysical Research Letters*, 46, 2772–2780, DOI: 10.1029/2018GL080261.

Wildfire Trends in California

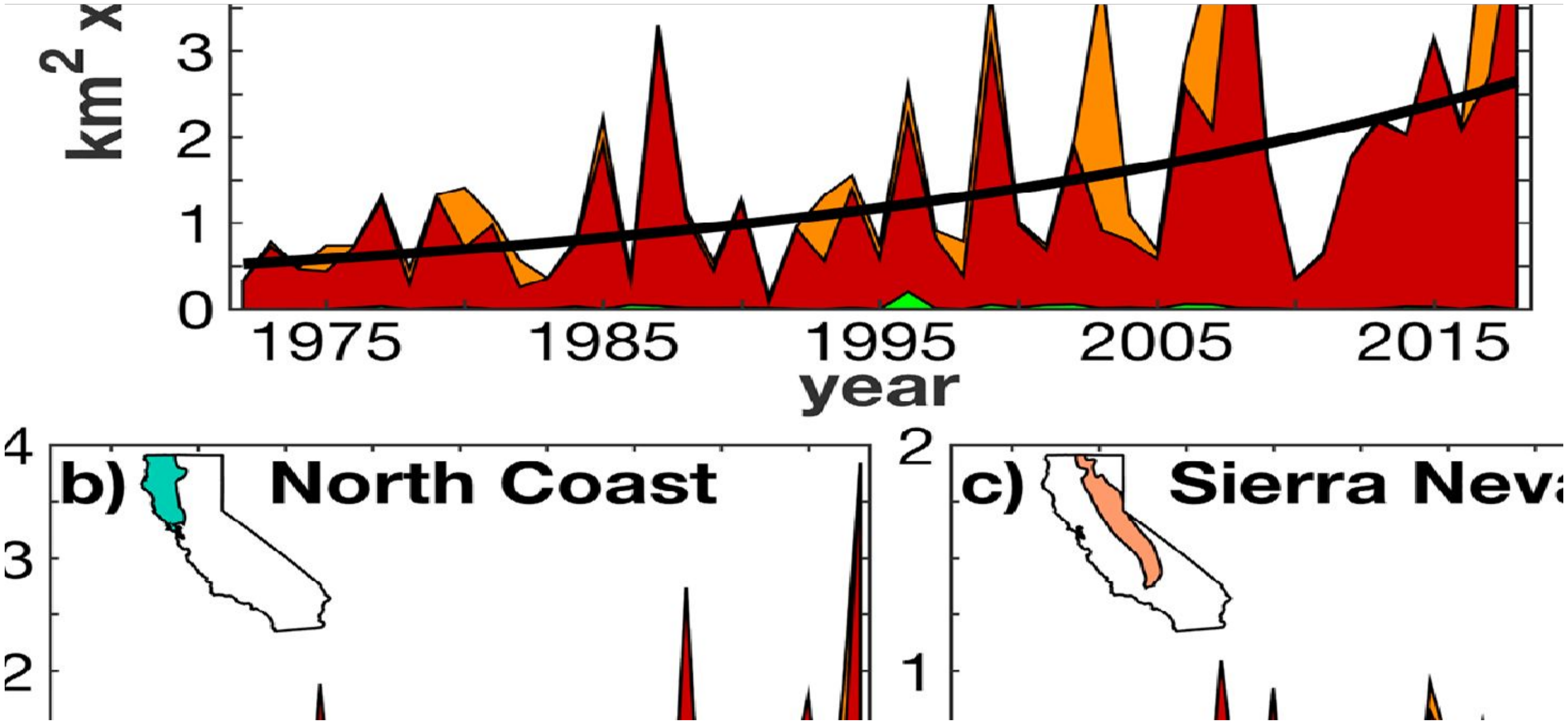


Figure 1. Seasonal and annual burned areas in California for 1972–2018. (a) Total burned area in the four regions of focus: (b) North Coast, (c) Sierra Nevada, (d) Central Coast, and (e) South Coast. Annual burned area is decomposed into that which occurred in January–April (green), May–September (red), and October–December (orange). Significant ($p < 0.05$) trends are shown as bold black curves.

Williams A.P., J.T. Abatzoglou, A. Gershunov, J. Guzman Morales, D.A. Bishop and D.P. Lettenmaier, 2019: The link between anthropogenic climate change and wildfire in California. *Future Earth*, 7. https://doi.org/ 10.1029/2019EF00121.

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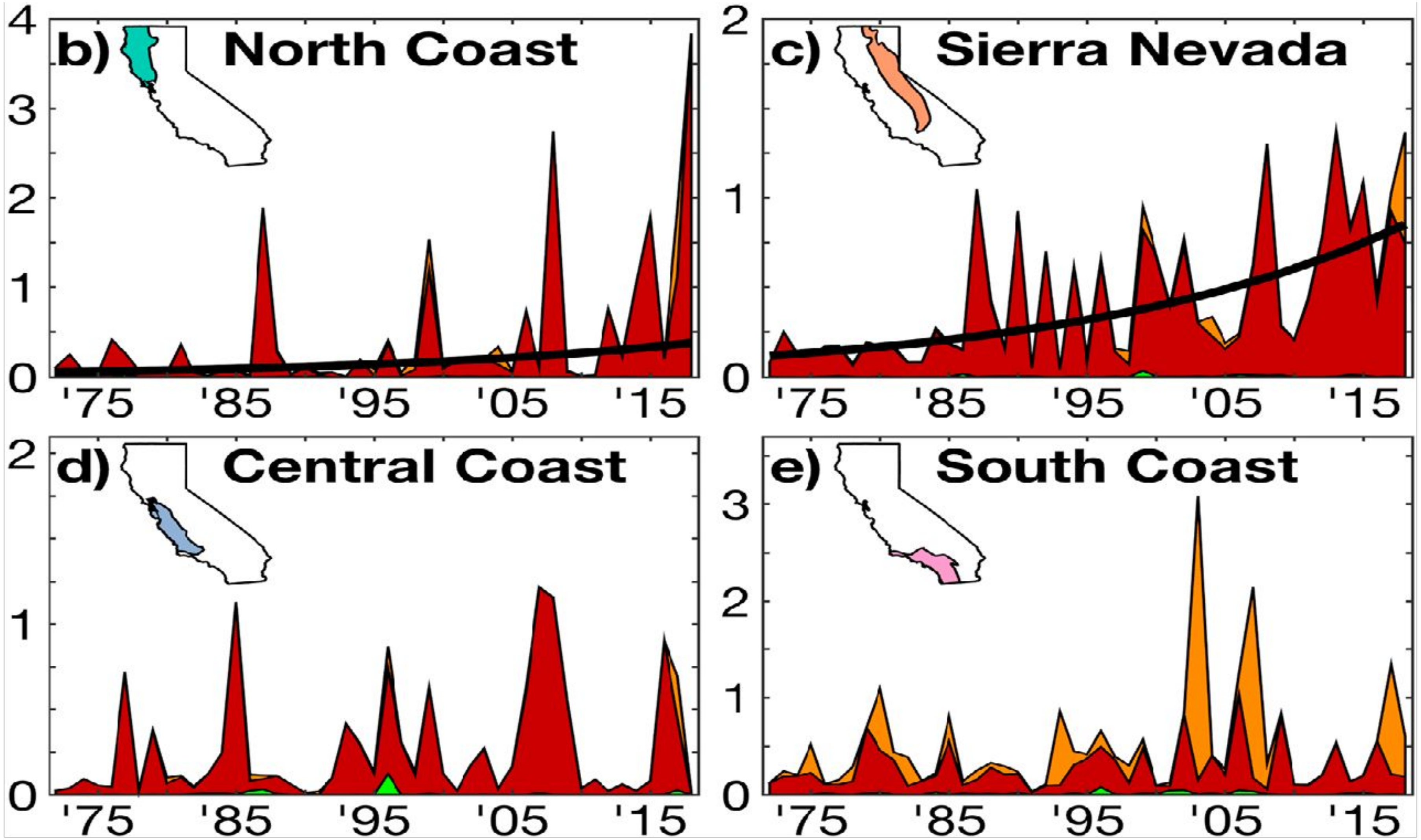

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Wildfire Summary

- On the increase over the mountainous West in forest ecosystems.
- Santa Ana wind frequency will likely decrease with climate change, particularly around the edges of the season.
- Santa Ana winds are also expected to become hotter and drier. Connection to eroding snowpack.
- **In coastal California, wildfire season is expected to migrate towards December, when back-to-back downslope winds can drive larger fires.**