Climate-change attribution related to wildfire

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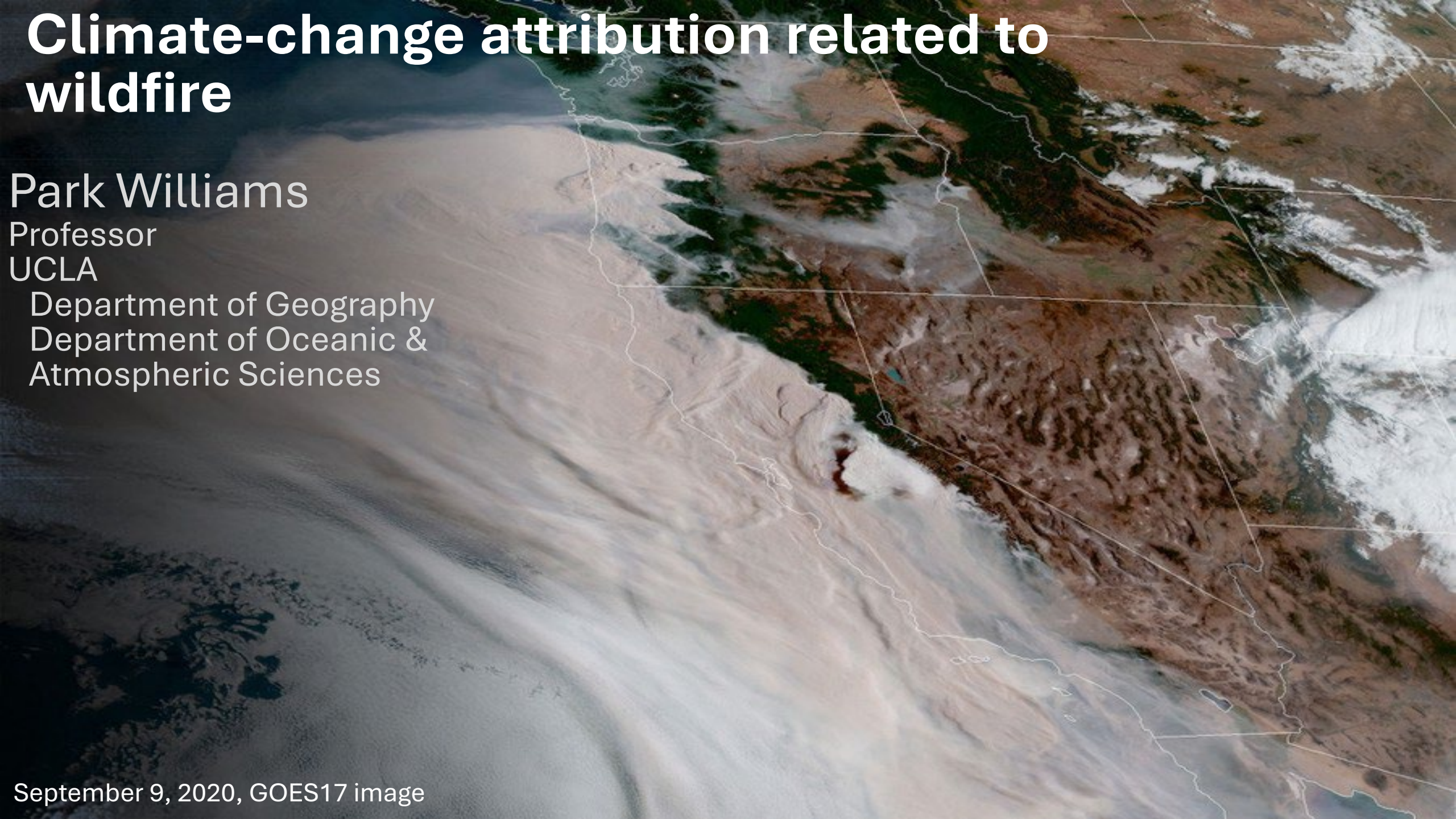
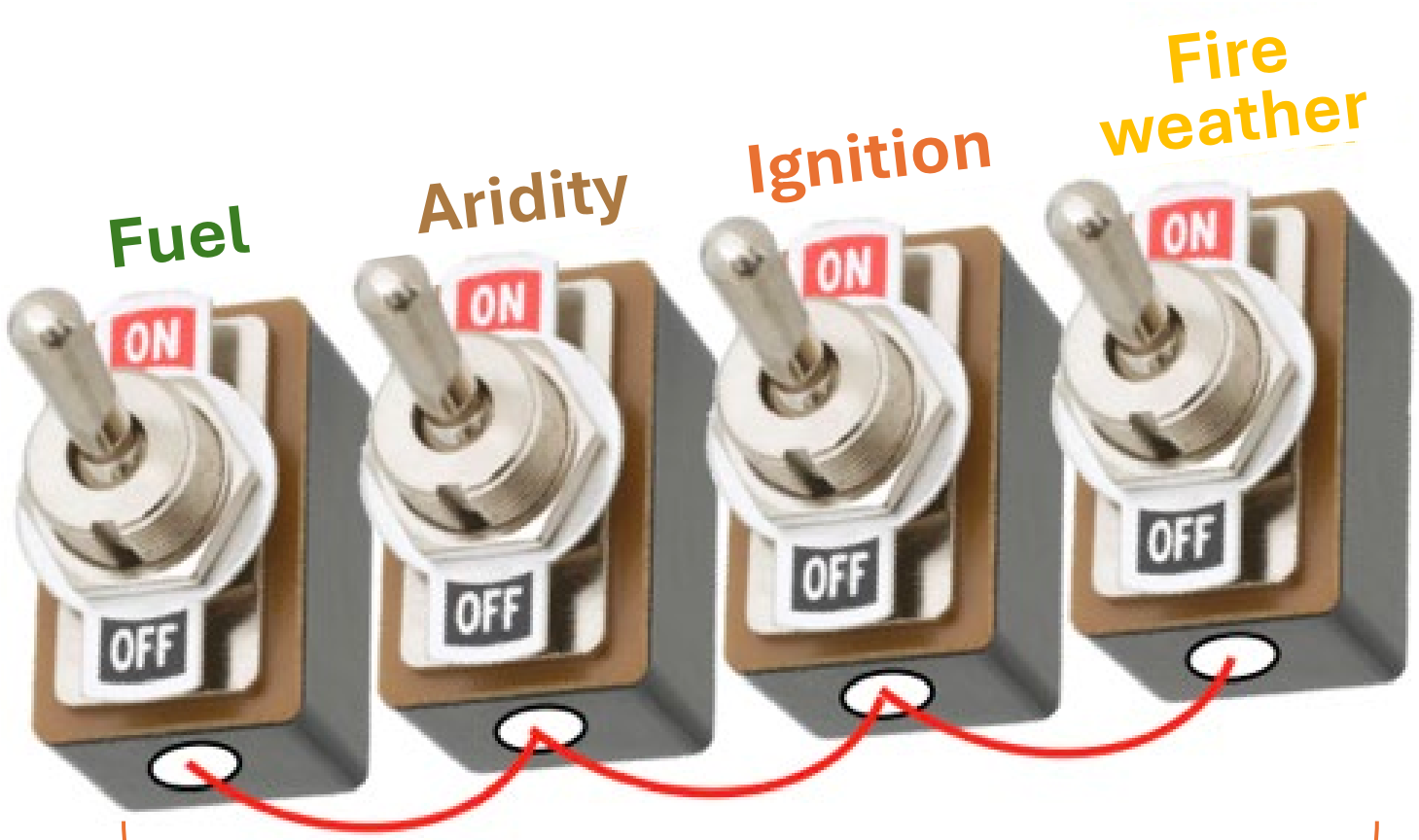


September 9, 2020, GOES17 image

THE FOUR SWITCHES FOR WILDFIRE

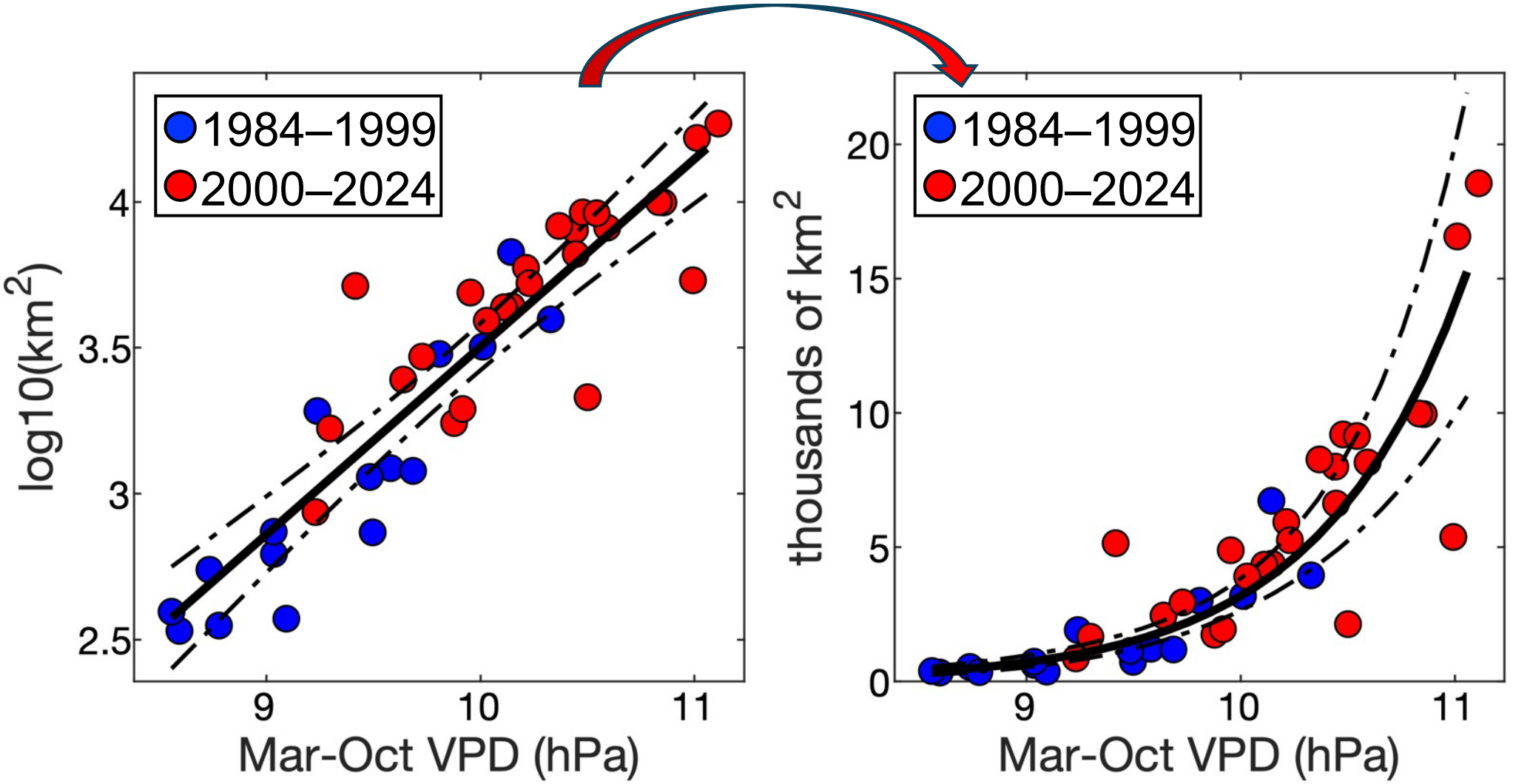


Impacts

- Loss of life / property
- Smoke pollution
- Terrestrial carbon loss
- Ecosystem shifts
- Floods, mudslides, water pollution

FIRE RESPONDS TO FORCINGS NON-LINEARLY

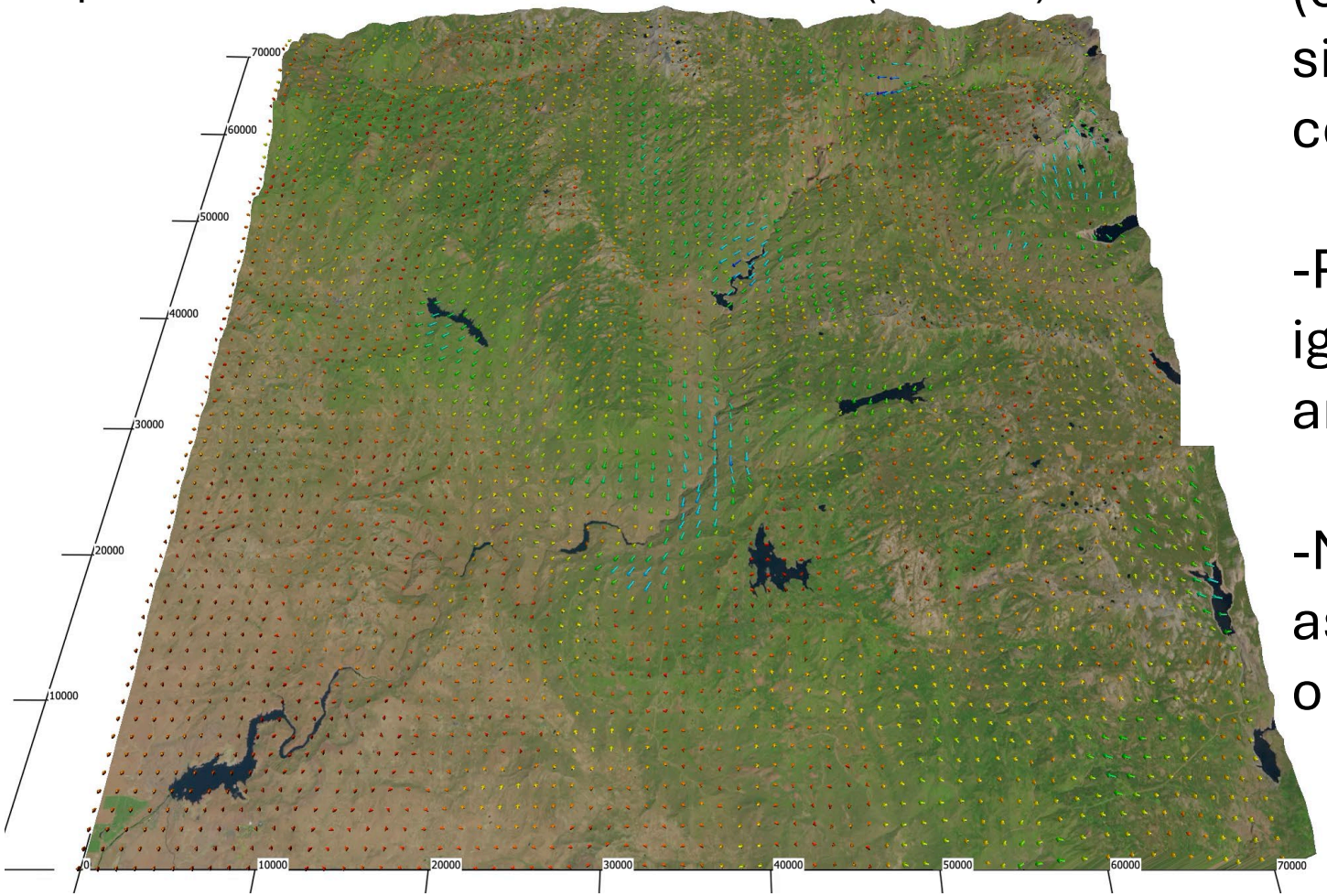
Annual west US forest-fire area vs vapor-pressure deficit



Wildfire dataset compiled by my group using satellite and government records

THE MOST PHYSICALLY BASED (MECHANISTIC) FIRE MODELS ARE NOT CURRENTLY SUITABLE FOR CLIMATE-CHANGE ATTRIBUTION

Simulation of California's 2020 Creek Fire with the Coupled Atmosphere-Wildland Fire Environment Model (CAWFE)



https://www2.mmm.ucar.edu/people/coen/files/newpage_m.html

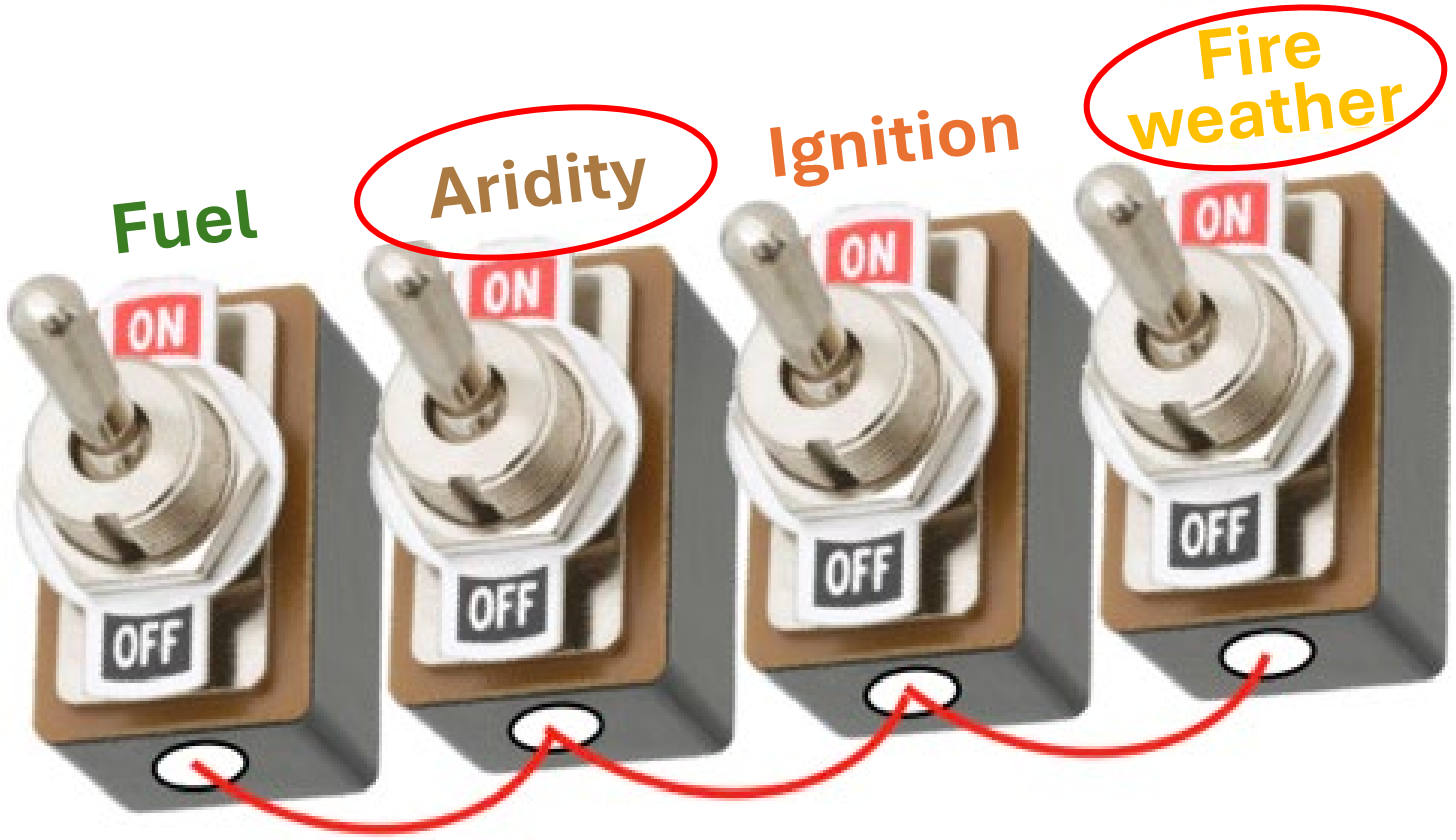
Coupled fire-atmosphere models (e.g., WRF-Fire) produce impressive simulations of fire spread, but are very computationally intensive

-Prescribed vegetation cover, likely ignoring effects of recent climate anomalies on fuel abundance

-Not ideal for large ensembles to assess wide ranges of potential outcomes

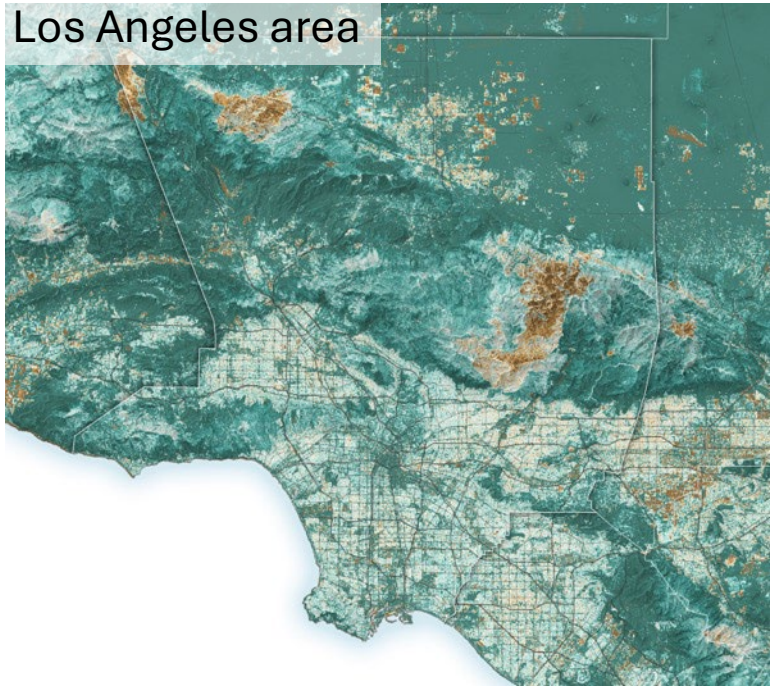
DETECTION AND ATTRIBUTION EFFORTS GENERALLY NARROW THE SCOPE TO ONE OR TWO IMPORTANT CLIMATE FACTORS

Climate-change attribution studies for fire generally follow traditional detection & attribution methods, selecting one or two well-know fire-relevant variables or indices.



CAVEATS OF APPLYING TRADITIONAL DETECTION AND ATTRIBUTION APPROACHES TO WILDFIRE EVENTS

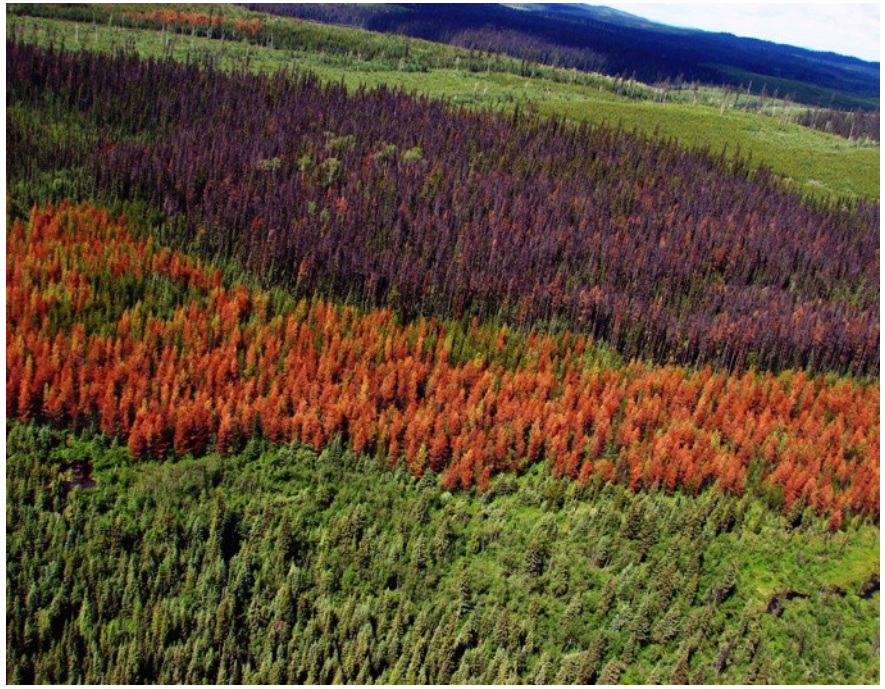
Commonly no consideration of the climate events that led to fuel loads



Summer 2024 veg greenness anomaly

https://earthobservatory.nasa.gov/

Fuel-moisture response to climate varies by fuel type, soils, etc



Dezene Huber, Simon Fraser Uni

Coarse climate models may not adequately capture fine-scale wind dynamics

https://abcnews.go.com

CAVEATS OF APPLYING TRADITIONAL DETECTION AND ATTRIBUTION APPROACHES TO WILDFIRE EVENTS

Climate models do not explicitly simulate lightning

www.reddit.com

The effect of climate on wildfire is filtered through human behavior

www.latimes.com

Pacific Palisades, Jan 7 2025, David Swanson

WHAT WE NEED FOR IMPROVED UNDERSTANDING OF CLIMATE-CHANGE IMPACTS ON EXTREME FIRE EVENTS

Fire models with the right blend of mechanism and parameterization to enable large ensembles to explore the wide ranges of effects promoted by observed and idealized climate scenarios

High-quality observed fire (and wind) datasets needed to parameterize models

High-resolution counterfactual climate datasets representing plausible scenarios of no climate change

Simulation of fuel dynamics, such as fuel accumulation in wet times

Simulation of effects of humans on fire probabilities and sizes

Ability to simulate plausible full counterfactual scenarios with pre-industrial fuels & fire regimes

UNDERSTANDING FIRE REQUIRES A BIG TEAM

Western Fire & Forest Resilience Collaborative

https://www.westernfireforest.org/

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Me
Professor, UCLA

Qian He
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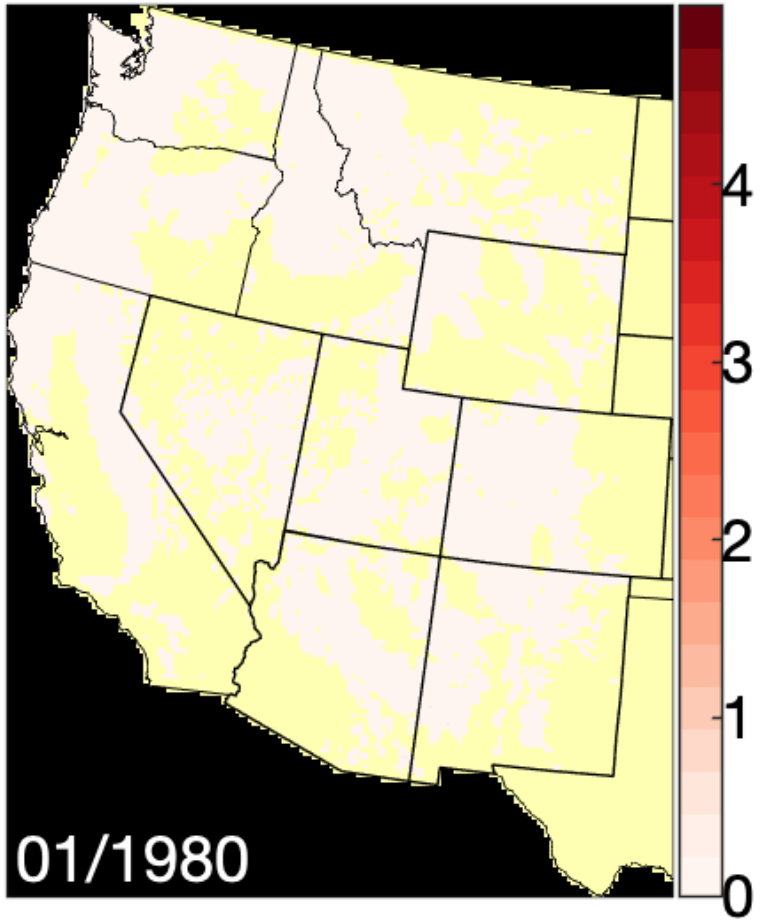
Caroline Juang
PhD student, Columbia

Gavin Madakumbura
Postdoc, UCLA

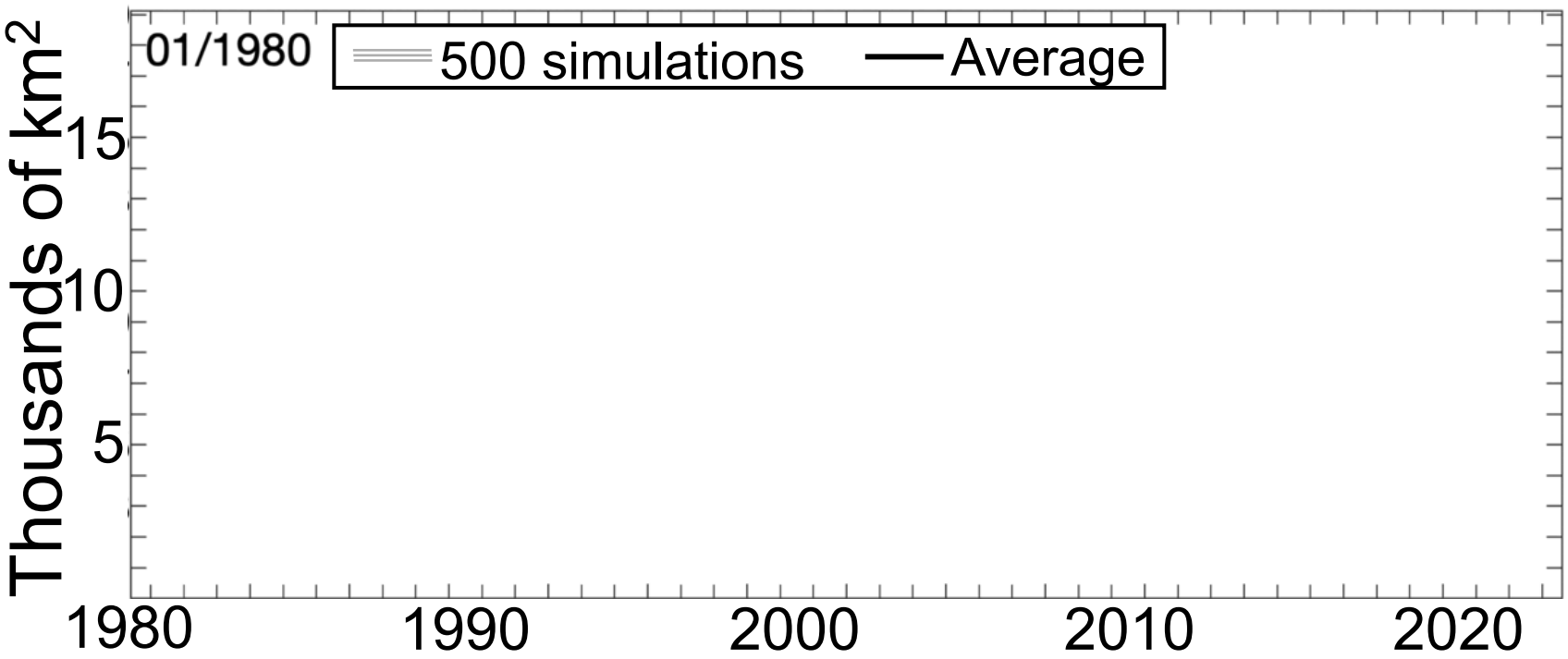
Miriam Johnston
Postdoc, Cary Inst

OUR NEW WESTERN US FOREST-FIRE MODEL

Monthly Fire Probability (%)



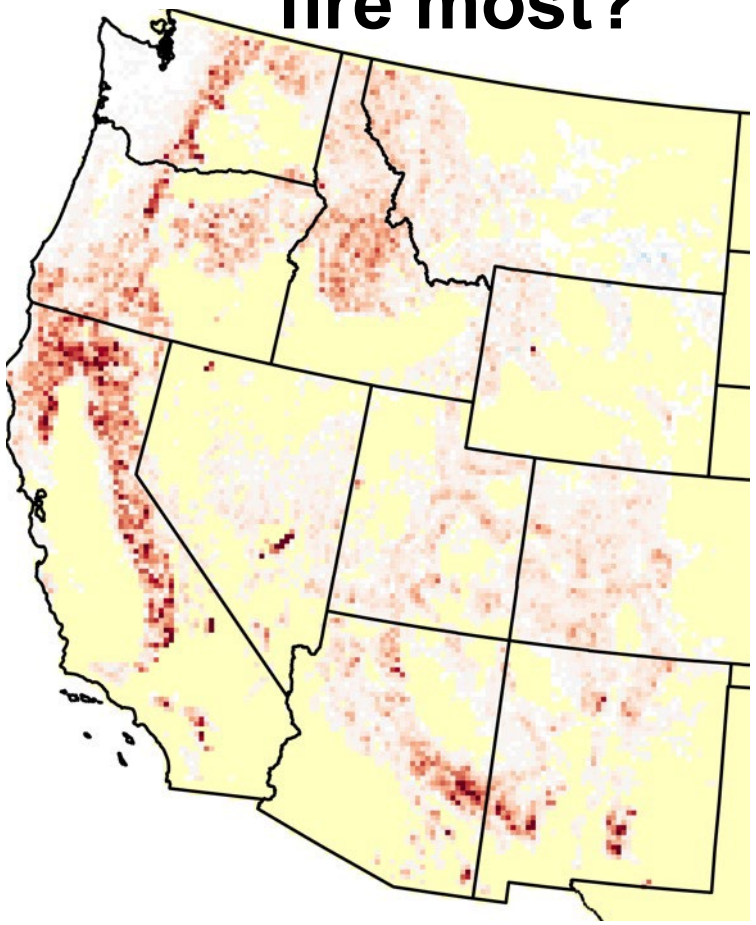
Monthly Simulated Forest Fire Area

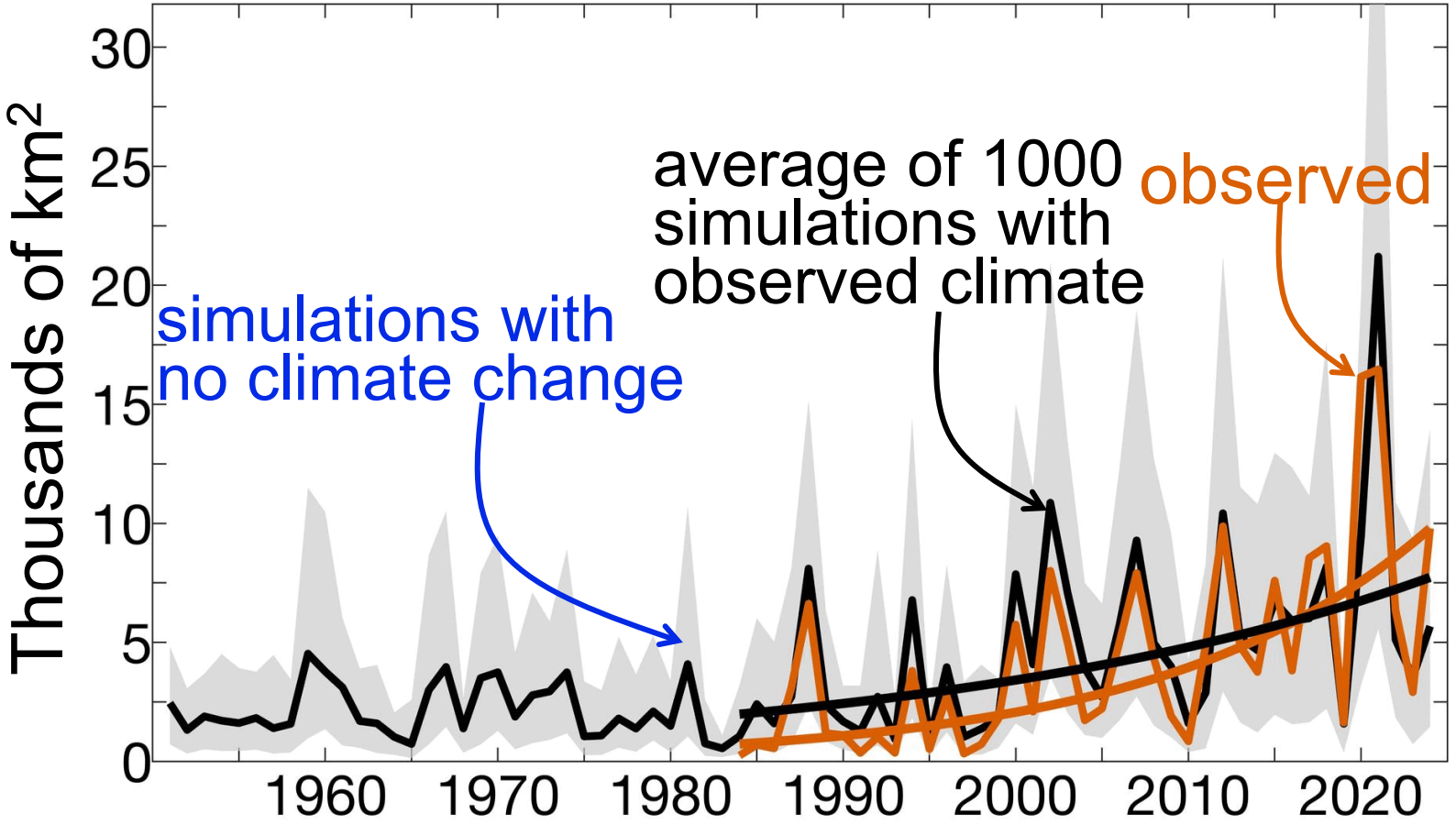


Williams et al. (in prep)

HOW MUCH, AND WHERE, HAS CLIMATE CHANGE PROMOTED MORE FOREST FIRE?

Where has climate change promoted forest fire most?



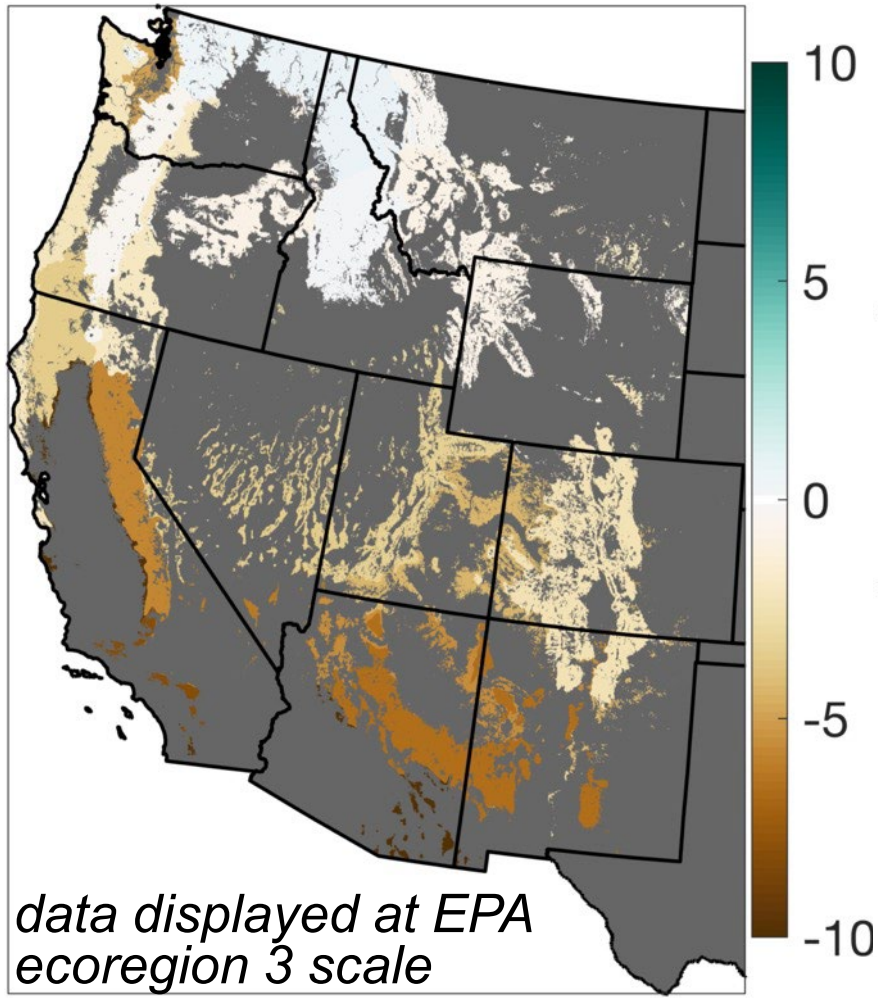


Williams et al. (in prep)

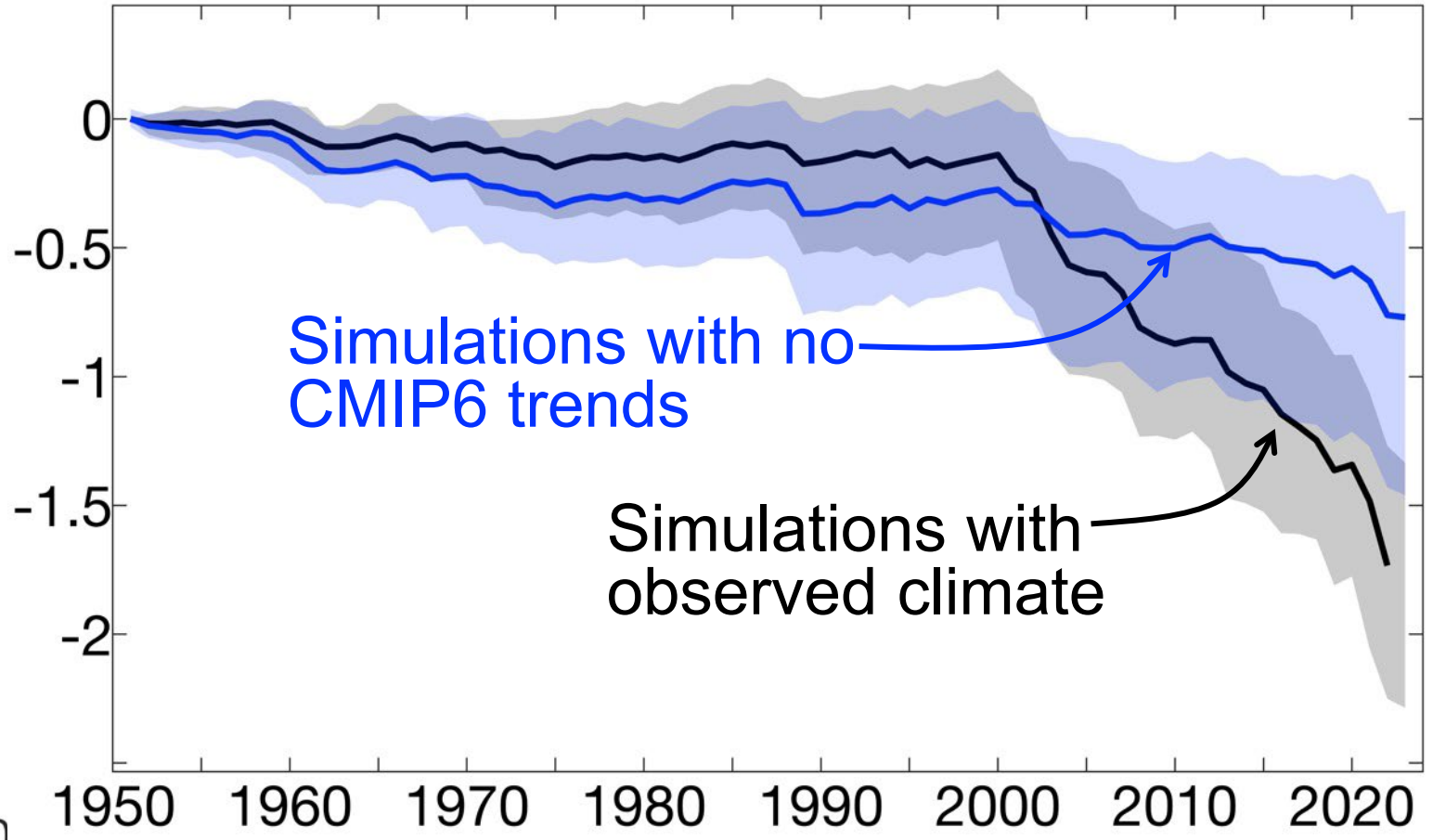
FOREST FUELS ARE CHANGING

This should alter how climate affects sizes, intensities, severities, and speeds of fire. Attribution work needs to track this.

% change in simulated forest biomass since 1951



Simulated % change in forest biomass since 1951

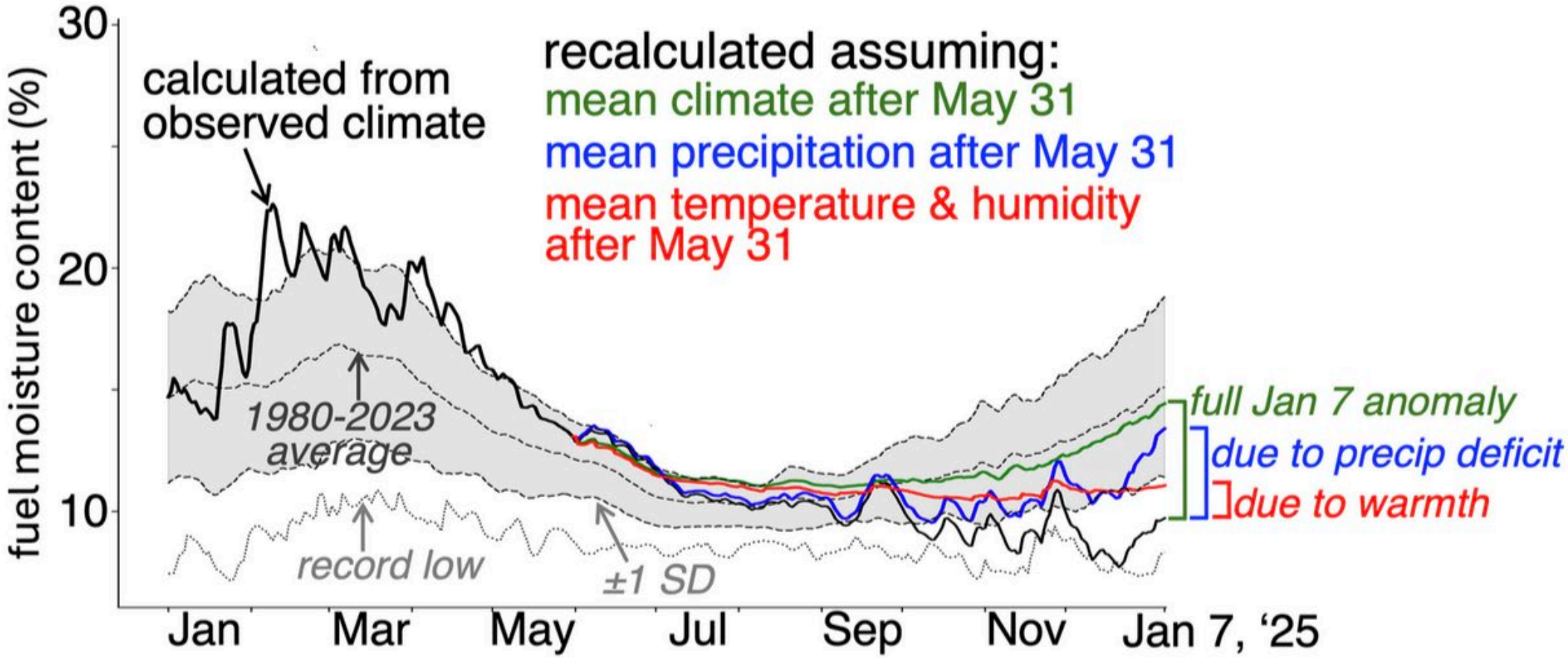


THANK YOU

Meadow Fire
Sep 2014
Peter B James

HOW DID ANOMALOUS HEAT CONTRIBUTE TO THE LOW FUEL MOISTURES IN LOS ANGELES IN JAN 2025?

Fuel moisture metric: 1000-hour dead fuel moisture



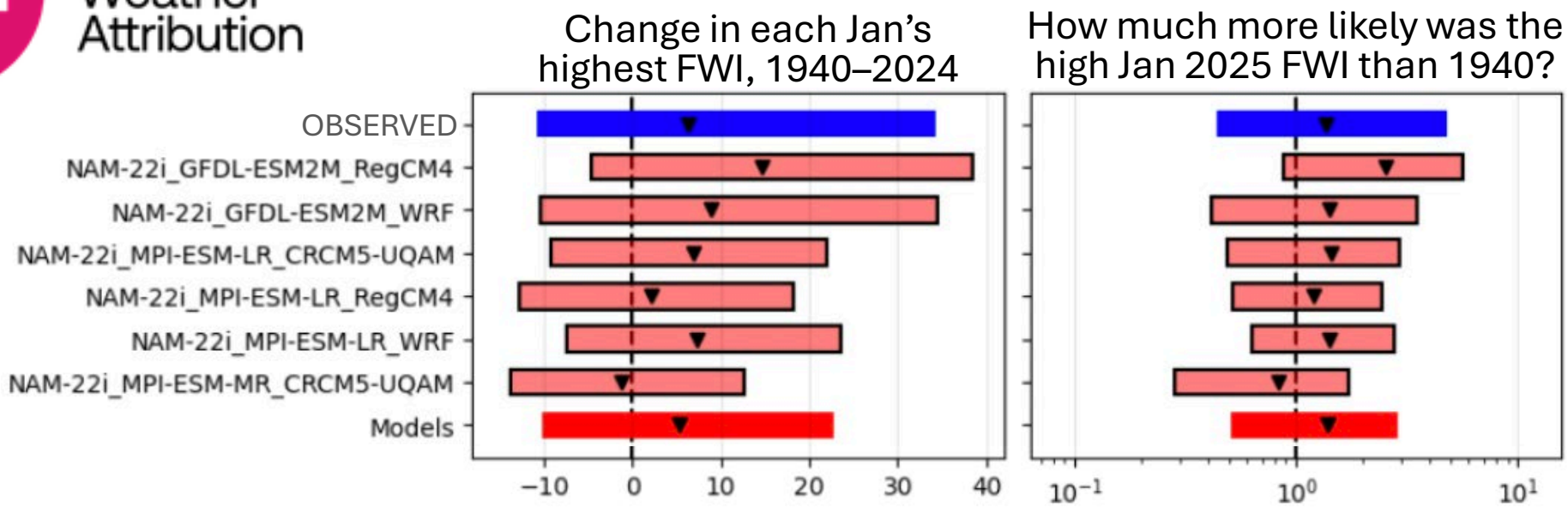
Our UCLA report here:
https://sustainablela.ucla.edu/2025lawildfires

Analysis by Gavin Madakumbura, UCLA

How did anomalous heat contribute to the low fuel moistures in Los Angeles in Jan 2025?

Fuel moisture metric: Canadian Fire Weather Index (FWI)

World Weather Attribution

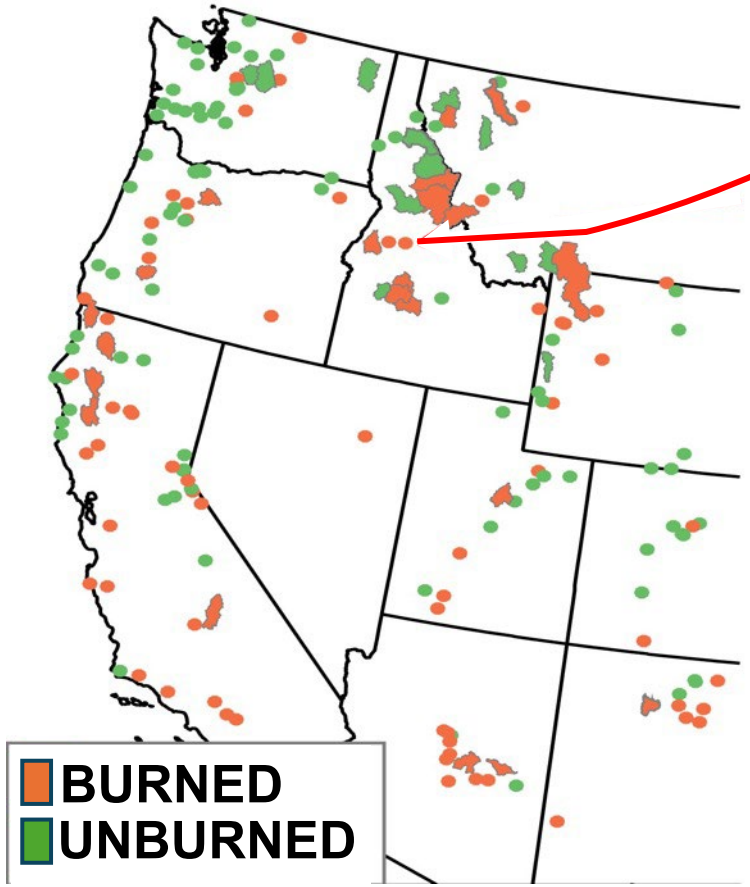


Observations and models suggest climate change enhanced the magnitude and probability of FWI extremes in southern CA by ~35%, though not statistically significant.

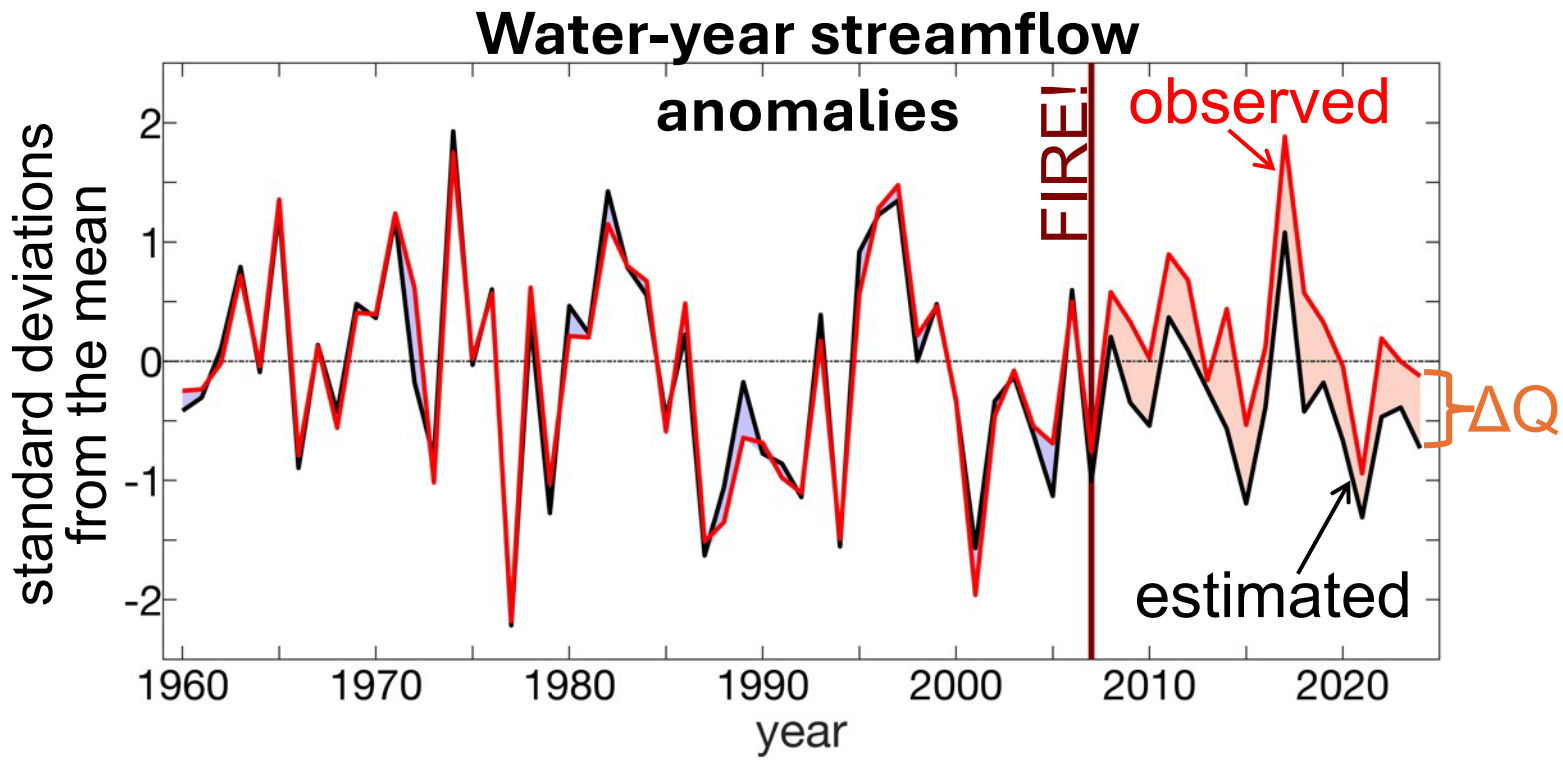
WWA repor: https://www.worldweatherattribution.org/climate-change-increased-the-likelihood-of-wildfire-disaster-in-highly-exposed-los-angeles-area/

HOW WILL INCREASINGLY LARGE AND SEVERE FOREST FIRES AFFECT WATER RESOURCES AND FLOOD HAZARDS?

85 Basins burned 1984–2023
99 Basins did not



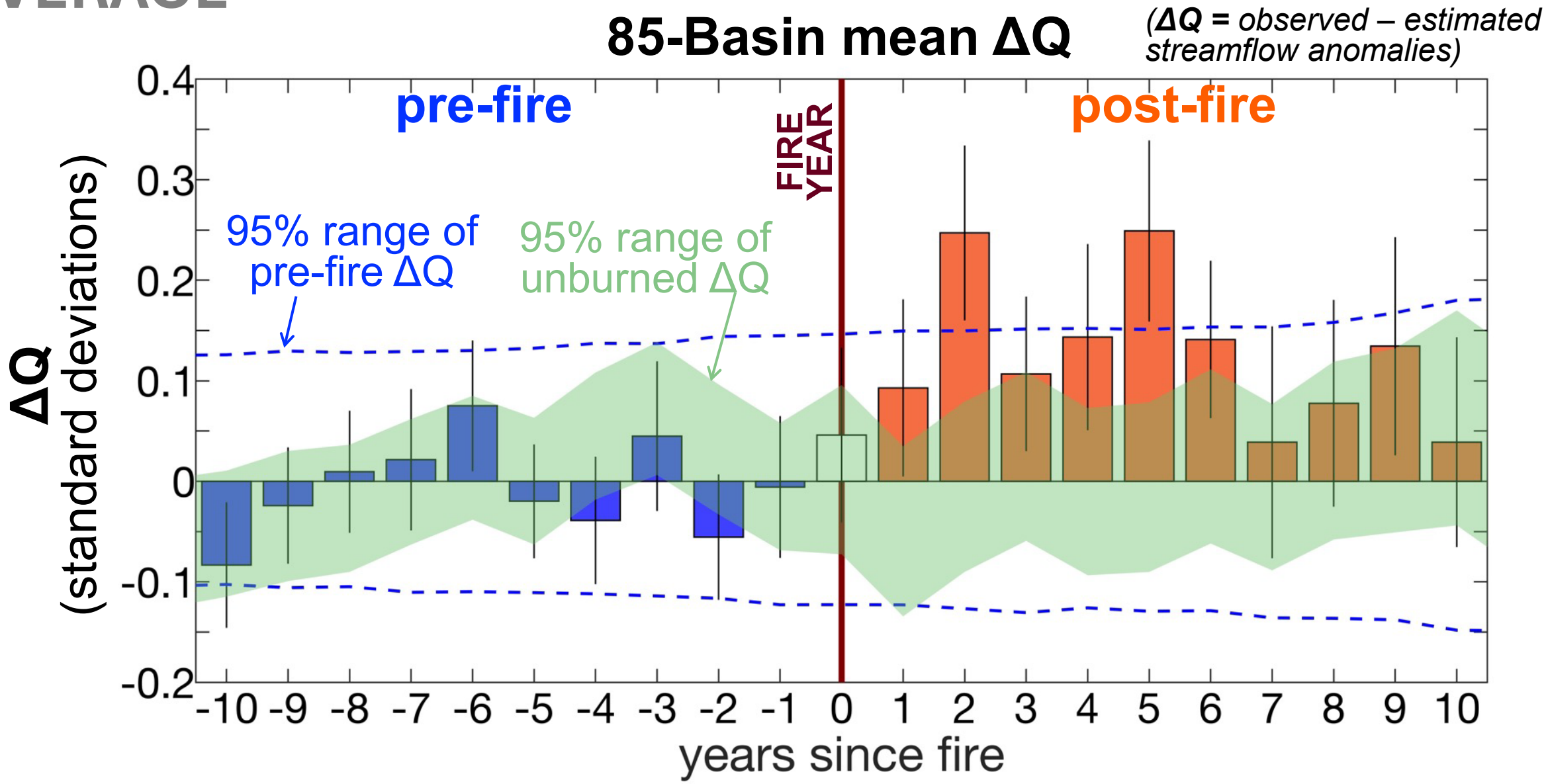
Example from Johnson Creek, ID



**standardized relative to 1970–2000*

Update of Williams et al. (2022; PNAS)

POST-FIRE STREAMFLOW BOOSTED FOR ~6 YEARS ON AVERAGE

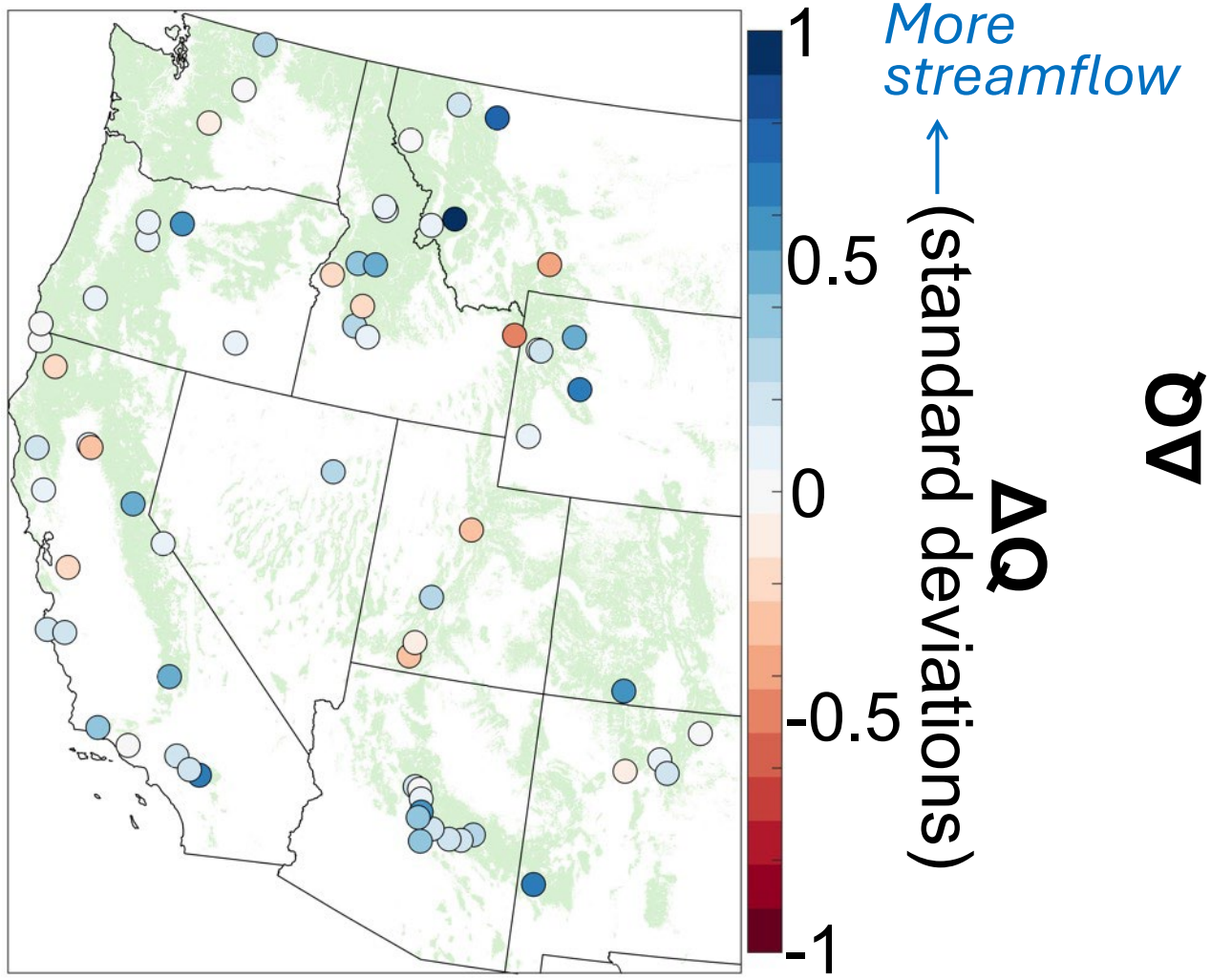


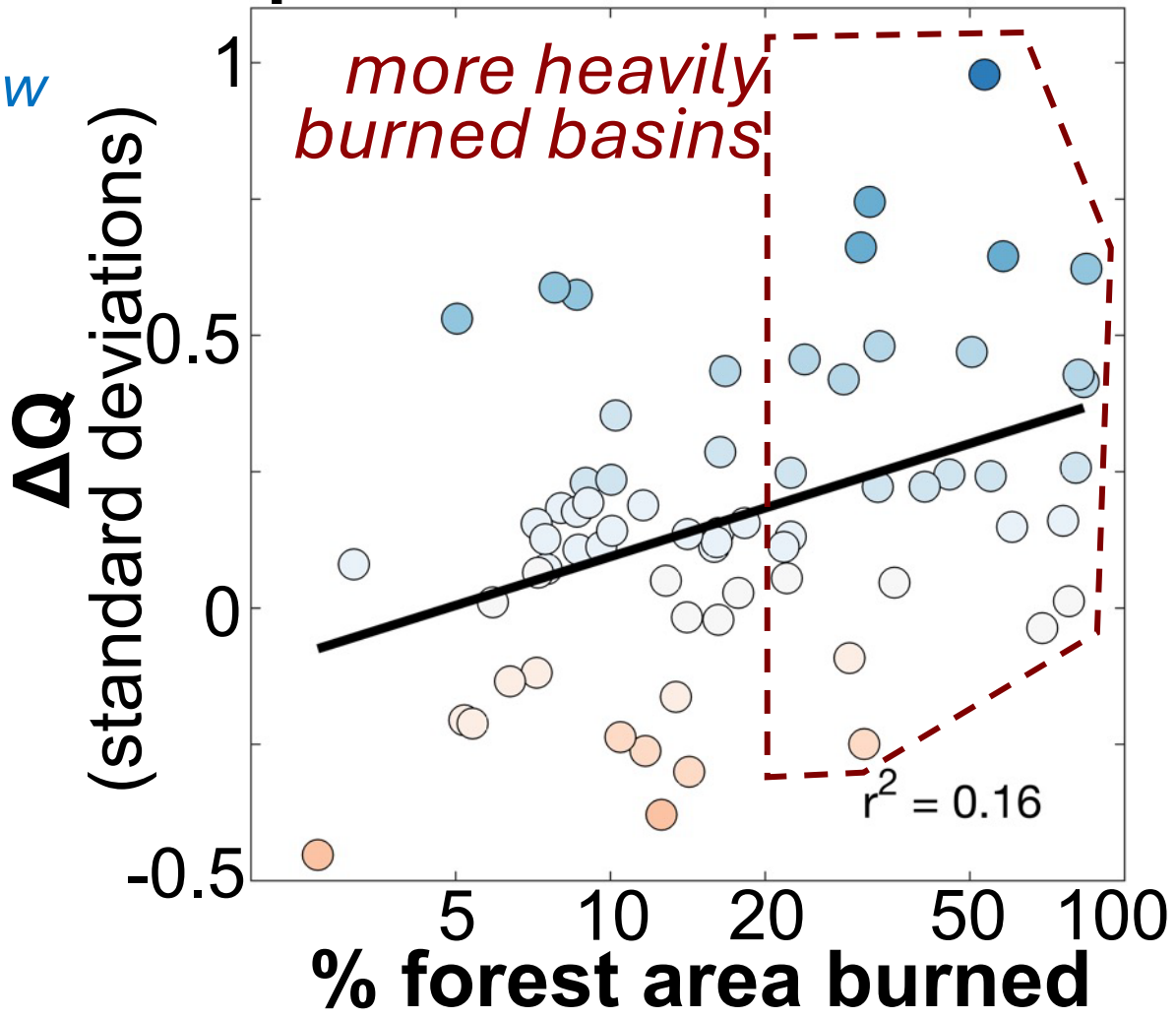
Update of Williams et al. (2022; PNAS)

HUGE RANGE OF POST-FIRE STREAMFLOW RESPONSES

There's a <u>weak</u> link to forest area burned (and severity) but much is unexplained.

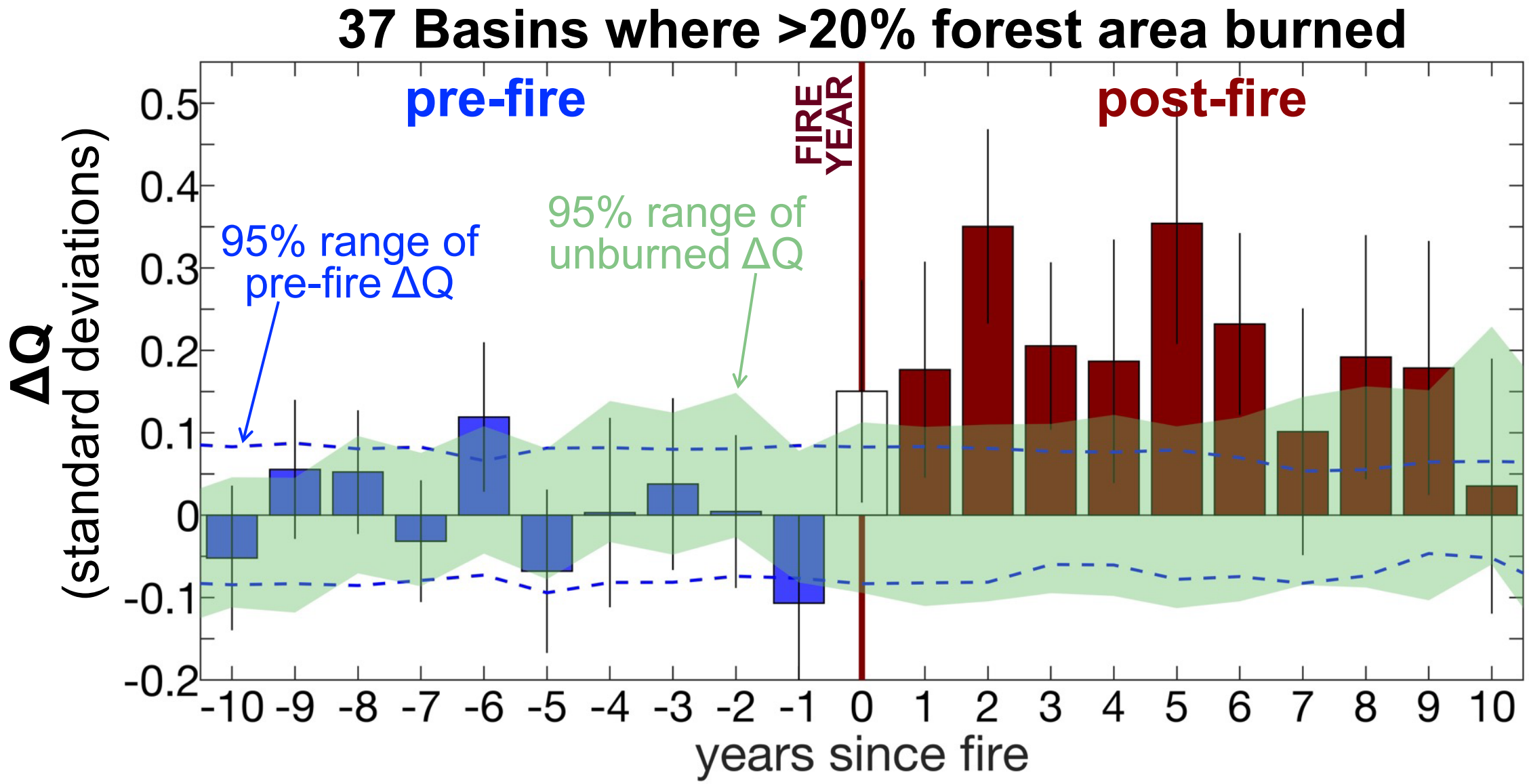
mean ΔQ in years 1–6 post-fire





Update of Williams et al. (2022; PNAS)

POST-FIRE STREAMFLOW BOOSTED MOST IN HEAVILY BURNED BASINS



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