Extreme Wildfire Events: Modeling toward attribution

Janice Coen(University of San Francisco and NSF National Center for Atmospheric Research)

Current approaches to assessing climate impact on wildfires:

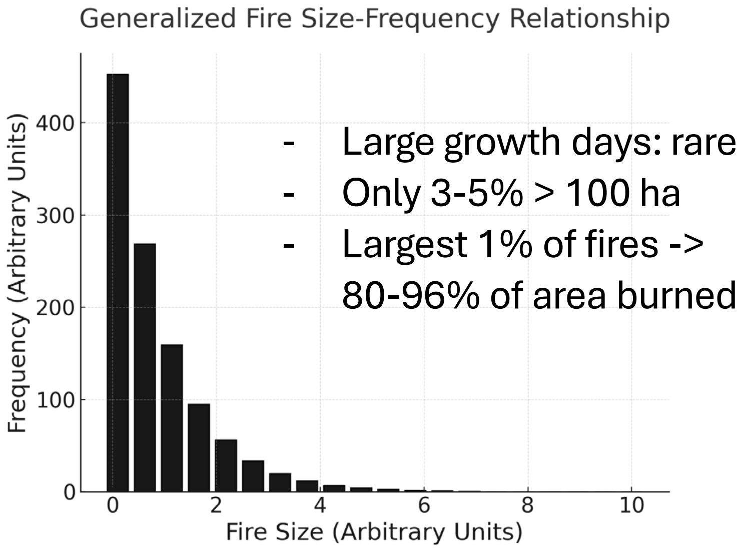
Susceptibility due to broad, slow changing factors **+** Ignitions

- Oversimplify, assuming a direct relationship between increased T or drought and more frequent, severe fires.
- Statistical correlations between climate & fire activity can lead to logical errors (correlation mistaken for causation)
- Nonlinear climate system dynamics often misrepresented as persistent linear trends -> inaccurate future projections.

Misinterpreting climate's role in wildfires can lead to flawed risk assessments and ineffective mitigation strategies.

However, fire growth is not solely determined by temperature and dryness.

- Variability in wind patterns, jet stream shifts, and short-term weather events play a dominant role.
- Also, extreme wildfire events are rare.



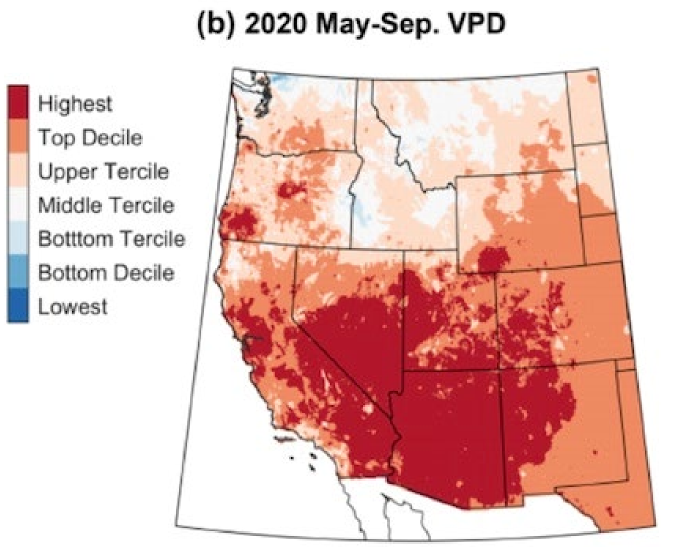
Hypothesis: extreme events result from a ***multi-scale*** coincidence:

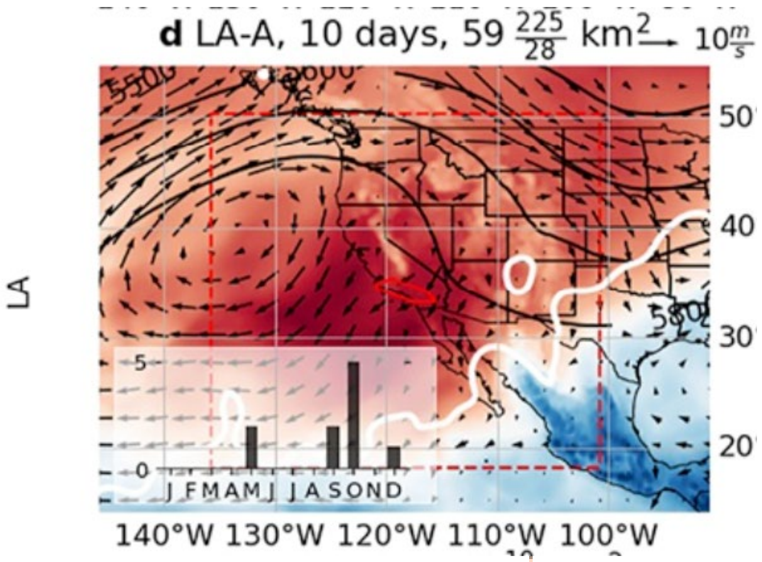
Susceptibility due to broad, possibly slow changing factors **+** A 1 - 5 day period of locationally-specific weather **+** A fortuitous ignition at right place and time

Enter: *Process-based wildfire behavior modeling*

Multiscale analysis of historical fires: Joining the scales

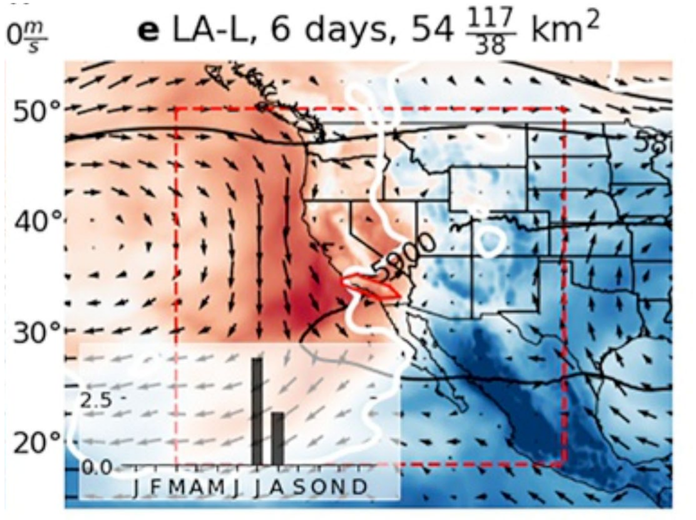
We can define fire weather types (WTs) that let us characterize fires by types and detect days with potentially extreme fire growth





Topography shape and features, atmospheric stability, airflow dynamics

Ex.: Woolsey Fire

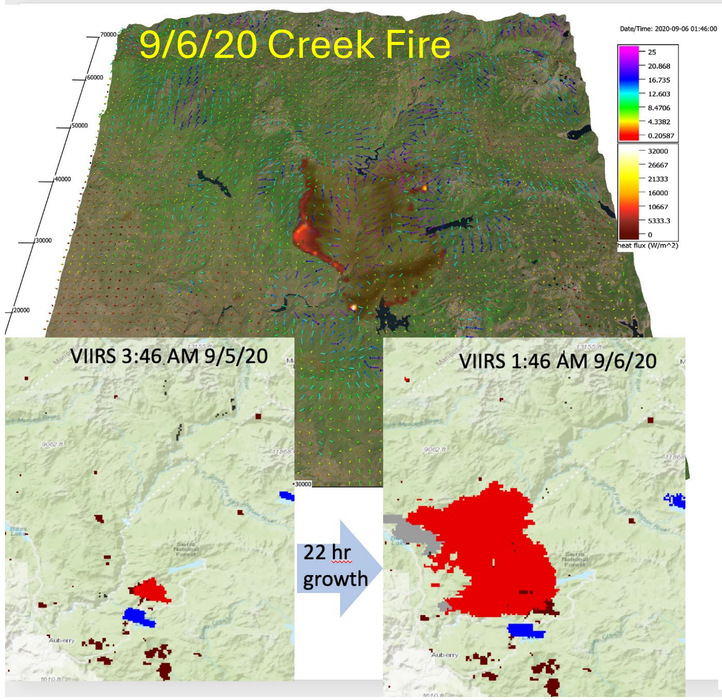


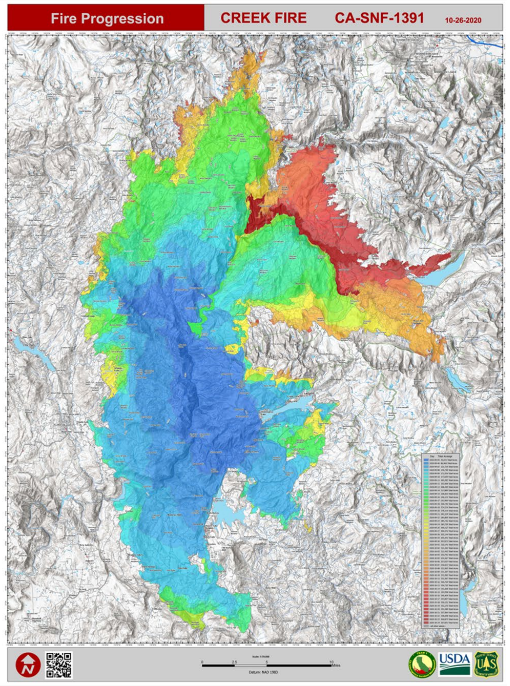
Inclined canyons, heavy mortality, a gentle nudge of wind upslope...

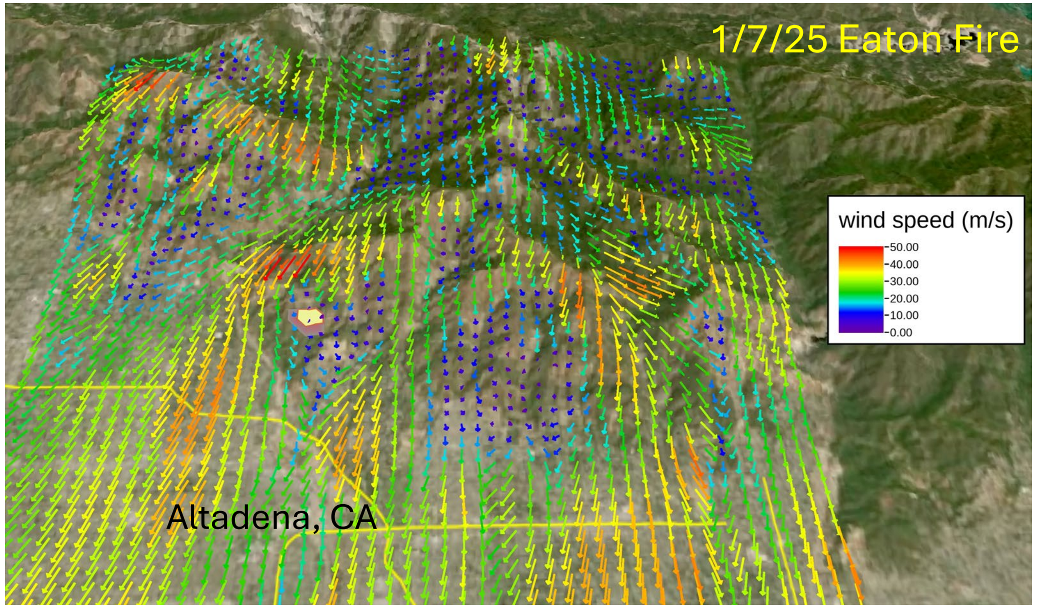
Ex.: Creek Fire

Underlying conditions + regional weather pattern + local factors + ignition = !!!!!!

Coupled weather-fire modeling of extreme events







- Coupled weather – fire behavior modeling (e.g. CAWFE™) has reproduced a wide spectrum of large wildfires
- Nested modeling grids refine to a few hundred meters
- If we accurately (1) capture winds at 100s of meters and (2) fire-atmosphere dynamic feedbacks, then we can reproduce fire progression, transient behavior, and fire phenomena
- Key factors: Fine-scale winds (NWP model dynamic core). Distant second: fuel amount, moisture state
- ***Even the most complex wildfire events are no longer unpredictable.***

However:

- Necessary modeling scales are OOM finer than NWP.
- “Calibration” (fudging), a holdover from legacy models, is rampant and often undisclosed
- No broad consensus on modeling skill, source of model error.

Physically-based model deconstruction of events reveals key drivers!

- When poor models fail to accurately extreme events (e.g. Creek Fire), behavior may be attributed to broad exogenous factors (e.g., climate change or fuel accumulation) rather than recognizing model limitations.