What causes extreme wildfire events?

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Large, destructive wildfires have become prevalent across the western U.S. and other fire-prone areas yet the mechanisms through which a specific fire became large and what environmental factors were important, particularly in light of varying climate, are frequently not understood. The most extreme events frequently lie at an end of a spectrum. At one end, fire growth is driven by strong ambient winds and is characterized by practitioners as a "wind-driven" event. At the other end of the spectrum, fire growth amplifies due to an internal feedback loop in which winds are generated by heat released by the fire itself ("plume-driven" events). The limitations of current generation operational fire models in simulating extreme fires in particular has enhanced perceptions that fire behavior has become more unpredictable.

Progress has been made in understanding and predicting fire behavior by recognizing wildland fires and the atmosphere in which they occur as a fluid dynamical system. We draw from convective-scale (hundreds of meters horizontal grid spacing) simulations of the weather leading up to and fire growth during exceptional wildfire events exemplifying each type with the CAWFE® coupled weather-wildland fire modeling system using satellite active fire detection data and airborne fire mapping to initialize and evaluate event simulations. Results show that even extreme fire behavior may be modeled, provided that fine-scale circulations are well represented and fire feedbacks upon circulations are included. Large, destructive wildfires may be driven by internal feedbacks or small-scale circulations thus may surprise due to the lack of apparent ambient triggers or exceptional conditions. In fires occurring during California wind events, while mesoscale weather forecasts capture broad spatial patterns of accelerated winds, CAWFE simulations that refine to convective scales show common factors such as a shallow river of fast-moving stable air but several different types of dynamic microscale flow regimes, where ignitions and rapid early fire growth appear linked to microscale phenomena and wind extrema coincident with ignitions attributed to electrical system anomalies. We examine our collective ability to reproduce extreme events and the challenges and limitations in our remote sensing systems, fire prediction tools, and meteorological models that add to events' mystery and apparent unpredictability.

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Refreshments 3:15pm

NCAR-Foothills Laboratory, 3450 Mitchell Lane, FL2-1022 Large Auditorium

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