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Fire Weather Science Across Scales and Horizons

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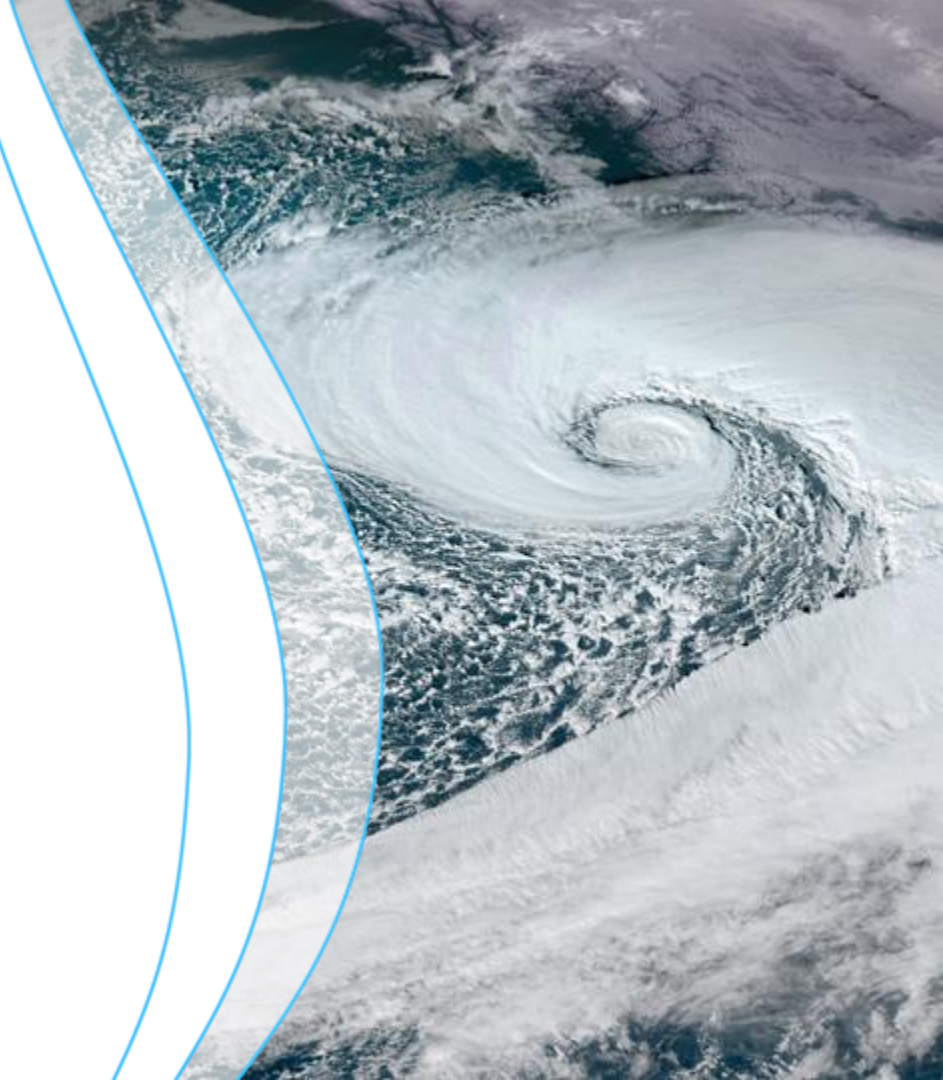
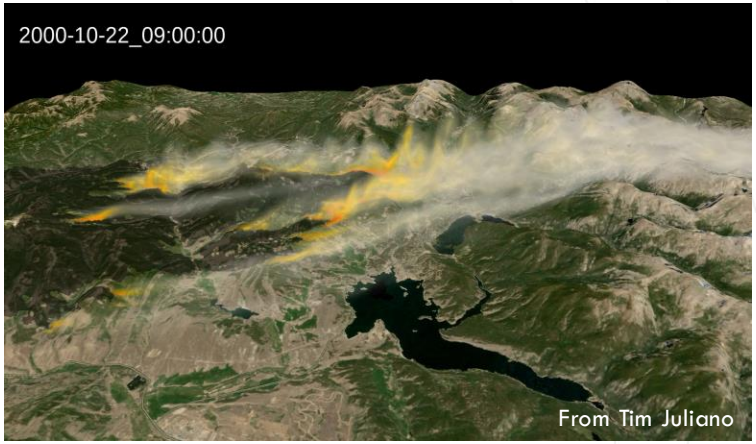
ESIG Forecasting & Meteorology Workshop



The hardest fire problems facing utilities aren't ones that any single model or institution solves alone. Research provides the physical foundation, utilities bring operational reality, and useful tools come from putting those together

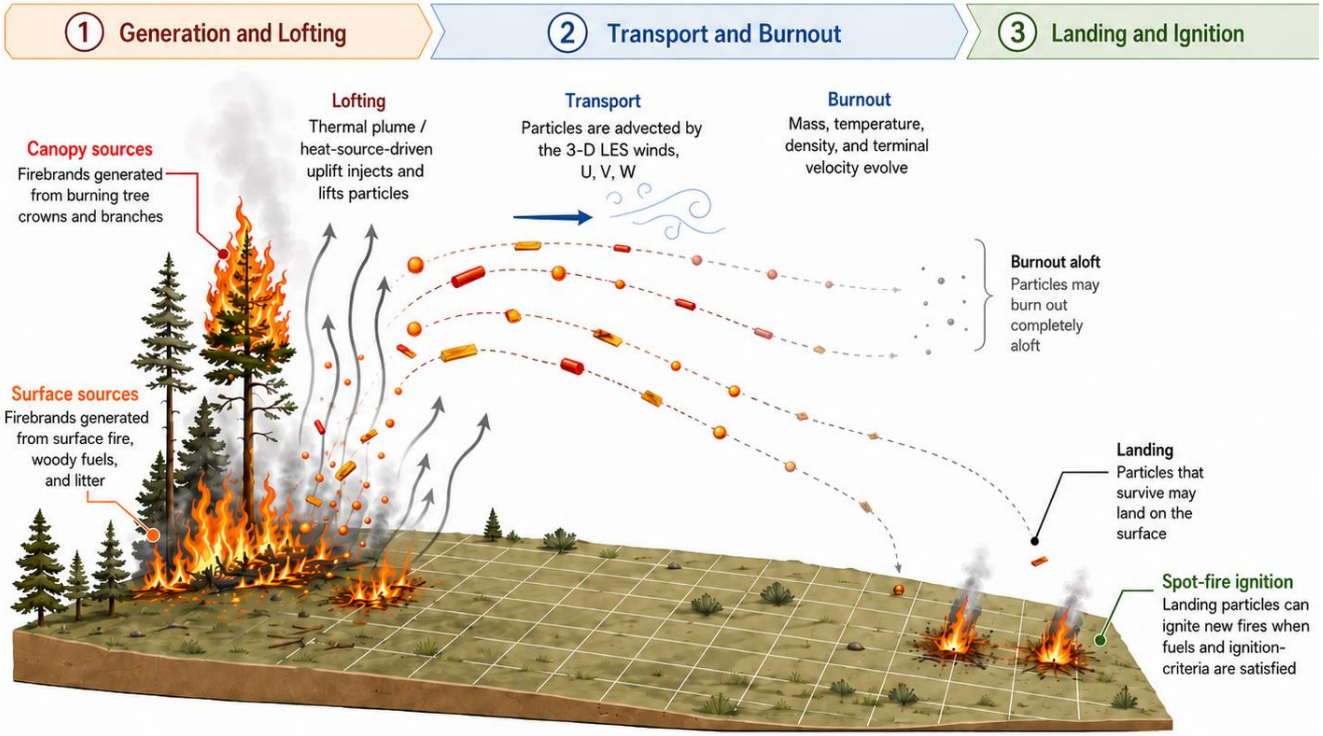
Where NSF NCAR Wildfire Research is Heading

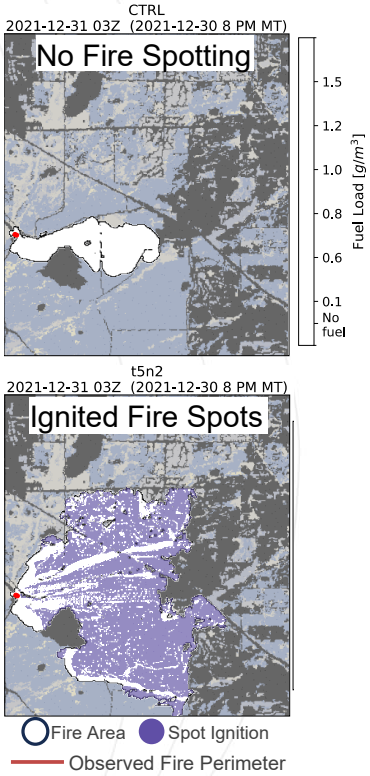
- **Built environment & Wildland Urban Interface (WUI)**
  - Unable to quantify fire behavior near structures
- **Meter-scale, terrain-driven processes**
  - Needed for local fire-atmosphere interaction
  - Not correct for mesoscale or health-hazard questions
- **Continental-scale downstream effects**
  - Active western US fire seasons feedback into (severe) weather elsewhere but current coupling incomplete



What We're Working On – Ember Transport

- **Embers drive most structure ignition and long-range spread**



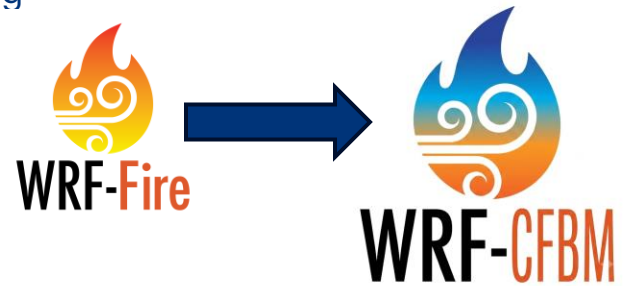


Ember Transport Modeling – Marshall Fire

Advancing the Modeling System

Building a Community Model Framework for Fire Weather

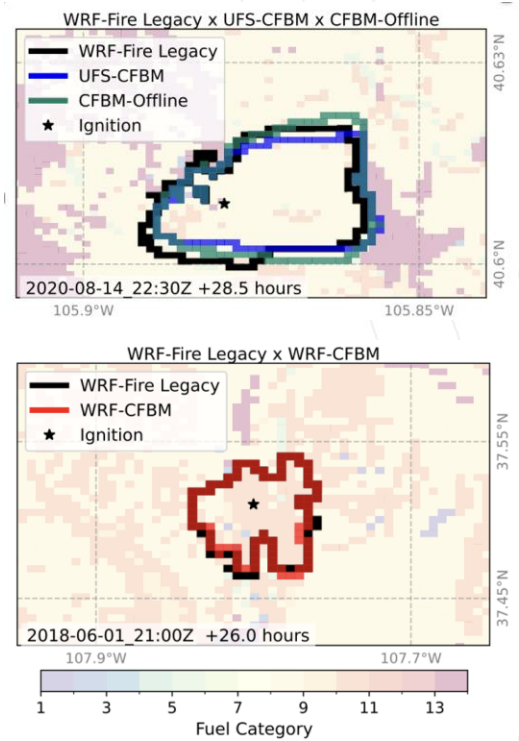
- Reimagined fire model framework
  - Access, Maintenance, Host-Agnostic, Modularity
  - Rothermel not developed for coupled fire-weather modeling
- Scale-oriented process representation
  - Range of spatial resolutions and process refinement
- Simplified fire state initialization
  - Incorporate new observations and parameters



Community Fire Behavior Model (CFBM)

Reimagined fire model framework

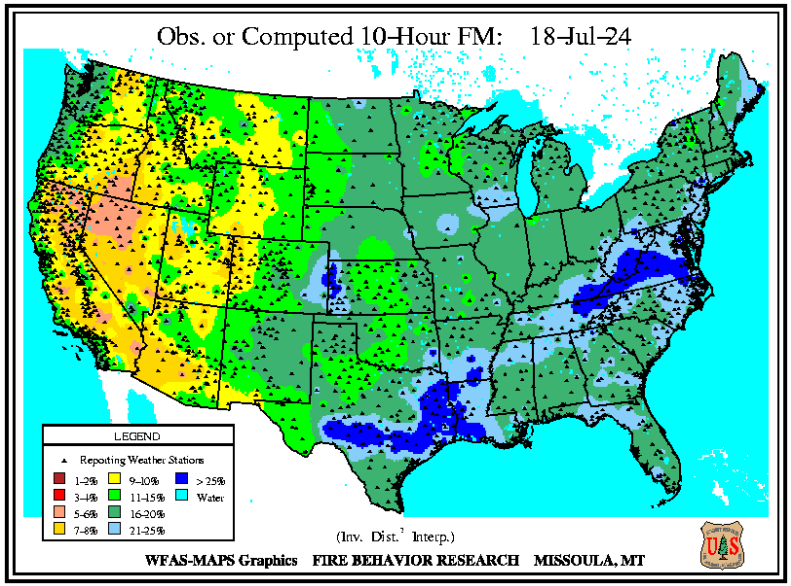
- Connect to any atmosphere model (WRF, UFS, MPAS)
  - Access to robust data assimilation systems (e.g. WRF/MPAS-JEDI)
- Self-contained independent repository
  - Sustainable maintenance
  - Update to standalone fire model immediately available to atmosphere model
- Modular internal components
  - Swapable options and new components (e.g. AI-based formulation, WUI components)

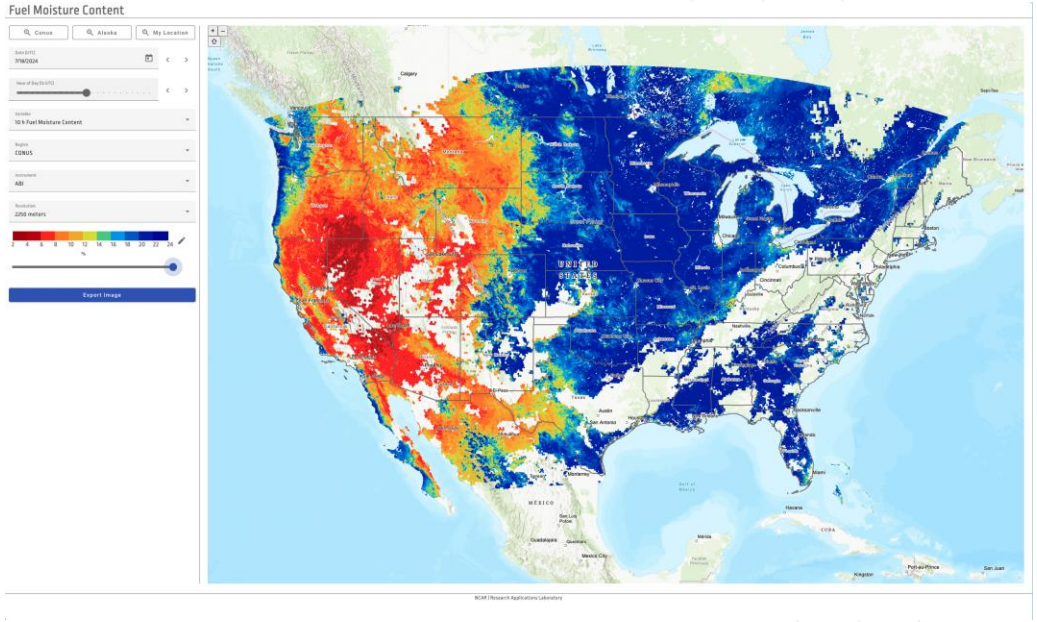


Jimenez y Munoz et al 2026, GMD

Wildfire Fuels

Estimated 10-hr dead and live fuel moisture content based on Machine Learning





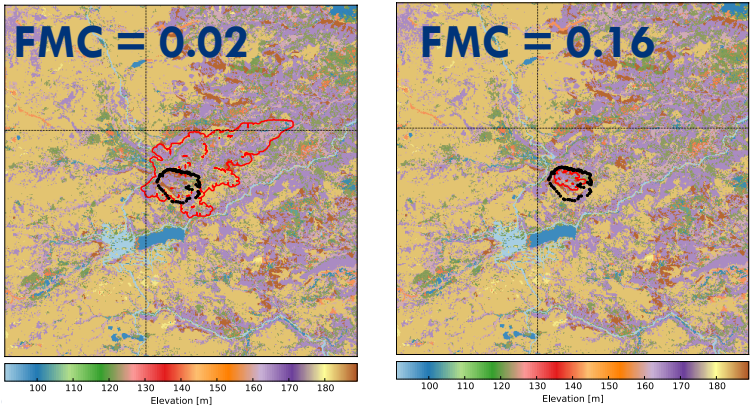
https://fmc.ral.ucar.edu

Schreck et al. 2023. DOI: 10.3390/rs15133372

Challenges & Opportunities

Challenges

- Funding landscape
- Observation data from controlled experiments may not represent extreme fire behavior
- Fuel data accuracy and fire start location are just as important as fire models, yet data are sparse



Opportunities

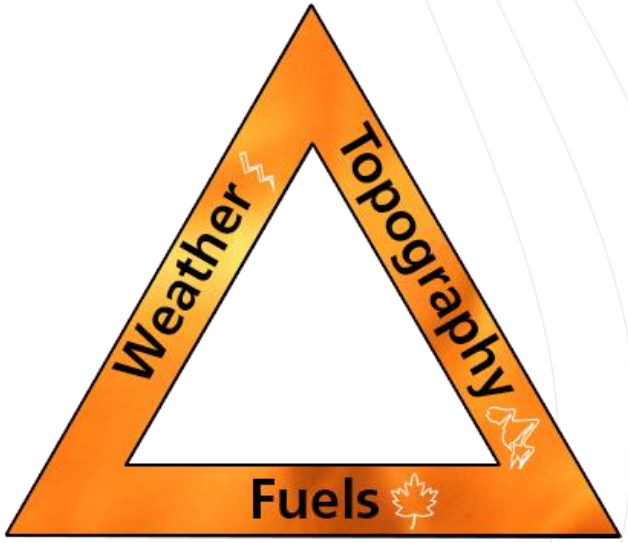
- Recent technology advancements for observations and data processing through AI algorithms
- Lessons from numerical weather prediction translate directly to fire modeling
- Best practices and caveats for new AI models can also be informed by weather prediction recommendations

What's next?

Convergence over divergence

Focus on difficulty of characterizing weather and fuels

Build on shared tools, new collaborations, and brainstorming together



Courtesy of the National Park Service

Looking Forward to the Conversation

CFBM: https://ral.ucar.edu/model/community-fire-behavior-model

Wildfire Fuel Dashboard: https://fmc.ral.ucar.edu

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