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Title: Pyrocumulus Collapse: Unpredicted Wildfire Dangers

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Pyrocumulus Collapse: Unpredicted Wildfire Dangers

Understanding Unexpected Wildfire Risk Using Numerical Models

BACKGROUND & MOTIVATION

The Las Conchas Fire occurred in Santa Fe National Forest near Los Alamos, New Mexico, on June 26, 2011.

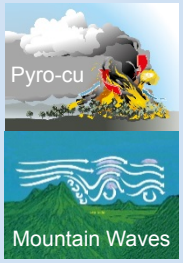
- The fire surprised everyone when it unexpectedly burned about 35,000 acres in less than 7 hours during its first night it was burning downhill in sparse vegetation and under milder wind conditions than had been present on that afternoon.

- The physical mechanisms for the nighttime blow-up of the fire were unknown yet.

INNOVATION

We propose two potential physical mechanisms for the fire blow-up.

1. **Downdrafts** associated with the soot-laden **pyro-cumulus column** (**pyro-cu**) that towered above the fire, causing a sustained density current carrying fire at high speed.

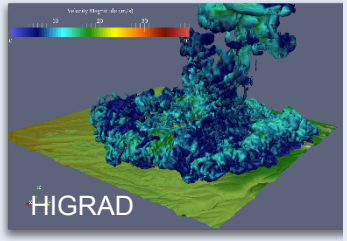


2. **Downslope windstorms** due to the **breaking of large-amplitude mountain waves** developed over Jemez Mountains near Los Alamos.

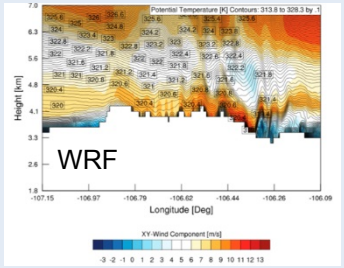
We provide insights on these mechanisms and explore their possible effects on wildfire behavior dynamics.

DESCRIPTION

We validate our proposed mechanisms with the aid of numerical simulations using a mesoscale atmospheric model (WRF; Weather Research and Forecasting model) **and LANL's local-scale dispersion model (HIGRAD;** High-GRADient model**).**

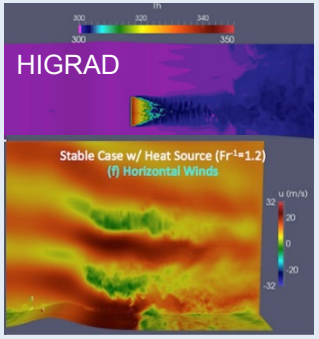


- High-resolution HIGRAD simulations illustrate that a rapid descent of heavier-than-air gas mixture due to its own weight (i.e., pyro-cu) could occur under certain atmospheric and wildfire conditions.



- WRF simulations indicate significant mountain-wave breaking that induces downslope windstorm and turbulent rotors in downstream of complex topography in the fire area.

- High-resolution HIGRAD simulations with localized, idealized wildfire-like heat source is largely affected by topographically generated gusty winds and rotors, describing the blow-up of the fire complicated by reversed winds associated with rotors.



Current Technology Readiness Level (TRL): 4

- HIGRAD has been revised to properly simulate the atmosphere-topography-fire interaction in idealized cases.

ANTICIPATED IMPACT

This research addresses important implications for wildfire research and wildfire/crisis management.

•Observed nominal atmospheric conditions from the first night of the Las Conchas Fire are likely to occur in a vast set of fire-susceptible communities bordering mountains across the country. We can:

- Save lives and safeguard critical government and industrial facilities under similar environments.
- Support USDA Forest Service wildfire research and management missions.

PATH FORWARD

Continue Research

- Simulate realistic atmospheric and topographic conditions for Las Conchas Fire.
- Identify high-risk conditions for this combined atmospheric/fire behavior.
- Continually wok to:
  - Improve computational efficiency of HIGRAD, or
  - Develop simpler models using high-resolution simulations, or
  - Develop fire-wind parameterization using high-resolution simulation.

Potential End Users:

- Wildfire modeling community, USDA FS, Laboratories, Insurance companies, etc.

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CONTACT INFORMATION

Please list the following contacts for the penta chart.

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LDRD Project Name(s): Pyrocumulus Collapse: Unpredicted Wildfire Dangers

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KEY WORDS

Please list keywords that will help people search for your penta chart.

Key Words: wildfire; Las Conchas Fire; nighttime blow-up; pyrocumulus; mountain wave; heat source; topography; HIGRAD; WRF; numerical model; downdraft; downslope windstorm; rotor; USDA Forest Service; infrastructure protection

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