THE FUTURE OF WILDFIRE PREDICTION

WRF–FIRE

Wildfire Weather-Behavior Support

Megafires have become the new normal for the American west. Attempting to manage them is like trying to manage a hurricane or tornado. These fires have devastated communities and risked the lives of first responders more profoundly than ever.

Fire behavior is complex, shaped by interactions among heat output, humidity changes, wind, updrafts and downdrafts, fuel, and terrain, naming only a few. The intensity and aberrant behavior of the largest and most aggressive fires pose life-threatening challenges to fire-management efforts. Decision-makers need weather- and wildfire-prediction tools to develop more effective strategies to protect property and lives.

ADVANCED WILDFIRE PREDICTION SYSTEM

To fight wildland fires, decision makers need reliable, accurate, frequently updated, readily accessible, geo-referenced information about current and predicted weather and fire behavior. With this information, decision makers can better determine how a fire is behaving now and might behave in the future. Reliable information about the potential for a fire to spread rapidly and behave erratically is essential for saving life and property.

Benefits & Impacts

- Accurate & reliable wildfire spread prediction
- Simulates the wildfire's effect on the local weather
- Decision support for wildfire-management
- Essential data for saving life and property

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Currently, operational systems that predict how wildland fires move and behave are not coupled to numerical weather prediction (NWP) models. These systems often rely on wind fields that lack critical details in space and time. Those are details essential to accurately predicting fire spread when winds change rapidly due to storm outflows, density currents, frontal passages, complex terrain, and other factors. Furthermore, large wildfires generate their own powerful updrafts and intense local winds, which drive flames quickly across the landscape. Large wildfires also generate vast, thick smoke plumes that can affect radiative transfer, while lofted particles and moisture can form pyrocumulus clouds. All of these phenomena can be predicted only by coupled models.

To fill this gap, scientists and engineers in RAL extended the functionality of the Weather Research and Forecasting (WRF) NWP model. New developments aim to improve the fire-spread model, investigate alternative fuel models and fuel-moisture data, allowing users to fine-tune fuel moisture in simulations, and predict where new spot-fires are likely to ignite. These developments are being included in the community WRF-Fire model. This modeling system is being extensively evaluated and improved, based on what we're learning from fires observed in Colorado and other parts of the United States.

COMBINING WILDFIRE & ATMOSPHERIC MODELS

Basic weather prediction is not enough to effectively inform fire-management strategies. To fill this gap, RAL scientists and engineers extended the Weather Research and Forecasting (WRF) numerical weather prediction model to simulate how a wildfire behaves in response to weather, fuel conditions, and terrain. In turn, the wildfire's effect on the local weather is also simulated. The model-generated fire and atmosphere continually co-evolve, predicting the fire's extent and rate of spread, flame length, heat, and smoke, thereby alerting firefighting personnel and local agencies to respond accordingly.

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WRF-Fire is a physics module within WRF ARW that allows users to model the growth of a wildland fire in response to environmental conditions of terrain slope, fuel characteristics, and atmospheric conditions, and the dynamic feedbacks with the atmosphere. It is implemented as a physics package with two-way coupling between the fire behavior and the atmospheric environment allowing the latent and sensible heat released by the fire to alter the atmosphere surrounding it, i.e. 'create its own weather'.

SOLUTIONS FOR SOCIETY

An NSF LEAP-HI project convenes scientists and engineers to develop a new computational platform to predict wildfire risks from days to weeks before a blaze ignites. Our effort in this collaborative project focuses on combining satellite imagery of land surfaces with highly detailed weather forecasts. These data will be fed into the WRF-Fire computer model, which will identify areas most at risk.

We develop tools that predict the behavior of wildfires to help firefighters, local authorities, and resource managers direct their efforts more effectively. Tactically placing firefighting personnel, equipment, and promptly notifying the public saves property, lives, and livelihoods.

WRF-Fire
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