NCAR Research Applications Laboratory
OPERATED BY UCAR

Community Fire Behavior Model

Wildfire Prediction for Better Decisions

Understanding how wildfires and weather interact helps communities and responders prepare, act, and stay safe.

Attempting to manage wildfires 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 such as heat output, humidity changes, wind, updrafts and downdrafts, fuel, and terrain. The intensity and chaotic 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 formulate better 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.

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

Benefits & Impacts

- Accurate & reliable wildfire spread prediction of wildland & wildland urban interface
- Simulates wildfire's effect on the local weather
- Decision support for wildfire management
- Real-time fire-weather forecasting
- Interoperability with atmospheric models: coupled to WRF & UFS models

Contact Us!

ral.ucar.edu
303.497.8422
info@ral.ucar.edu

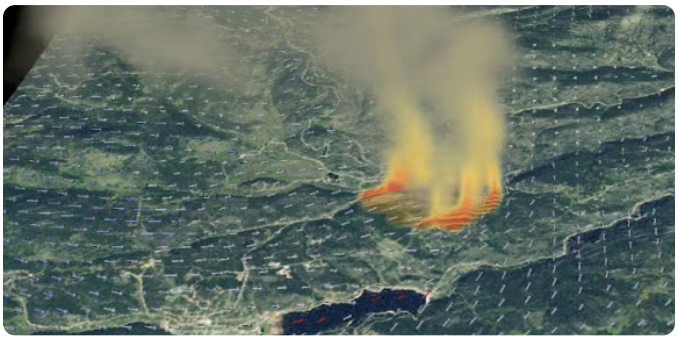
predicting fire spread when winds change rapidly due to storm outflows, density currents, frontal passages, complex terrain, and other factors. Furthermore, large wildfires generate their own powerful updrafts and intense local winds, which drive flames quickly across the landscape. Large wildfires also 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.

> Wildfires can change the weather around them and our models help anticipate what happens next.

To fill this gap, NCAR scientists and engineers developed the Community Fire Behavior Model (CFBM). The model can run uncoupled to the atmosphere allowing for rapid fire simulations like other systems, but it is also designed for interoperability with atmospheric models to capture fire-weather interactions. This leads to collaborations across modeling communities to foster joint developments and accelerate progress in fire-behavior modeling. New developments aim to improve the fire-spread model, incorporate better characterization of fuel properties, like fuel moisture content, and the simulation of fire progression in an urban environment.

Combining Wildfire & Atmospheric Models

Basic weather prediction is not always enough to actively inform fire-management strategies. To fill this gap, NCAR scientists and engineers have developed the CFBM, the first fire behavior model available as an Earth system component for coupling with atmospheric models. So far, the CFBM



Improving coupled wildland fire simulations

Reliable fire-spread information helps protect lives, property, and communities.

has been coupled to the Unified Forecast System (UFS) and the Weather Research and Forecasting (WRF) NWP models, which allows for forecasting how a wildfire behaves in response to weather, fuels, and terrain. In turn, the wildfire's effect on 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, smoke, and potential damage to structures, thereby alerting firefighting personnel and local agencies to respond accordingly.

The CFBM is open-source code and relies on modern software engineering practices to maintain and easily extend components benefiting from collaborations across the research community.

Solutions for Society

The CFBM is fostering collaborations across the research community to rapidly expand our fire-behavior capabilities to simulate impacts across a range of applications. The model is coupled to two of the most widely used atmospheric models, UFS and WRF, and we aim to couple it to the Model for Prediction Across Scales (MPAS). This collaborative framework should prove useful to advance our understanding of fire-weather interactions and mitigate some of the adverse impacts of wildland fires on society.

> Anticipating wildfire behavior gives communities a critical head start.

We develop tools that predict how wildfires will spread, helping firefighters position resources effectively, utilities know when to shut off power, and communities get warned on time. This head start saves property lives, and livelihoods.

RAL.UCAR.EDU

NCAR OPERATED BY UCAR Research Applications Laboratory

This material is based upon work supported by the NSF National Center for Atmospheric Research, a major facility sponsored by the U.S. National Science Foundation and managed by the University Corporation for Atmospheric Research. Any opinions, findings and conclusions or recommendations expressed in this material do not necessarily reflect the views of NSF.