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Rocky Mountain Research Station

Science You Can Use *(in 5 minutes)*

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Smoke: How new emissions data could enable more prescribed fire

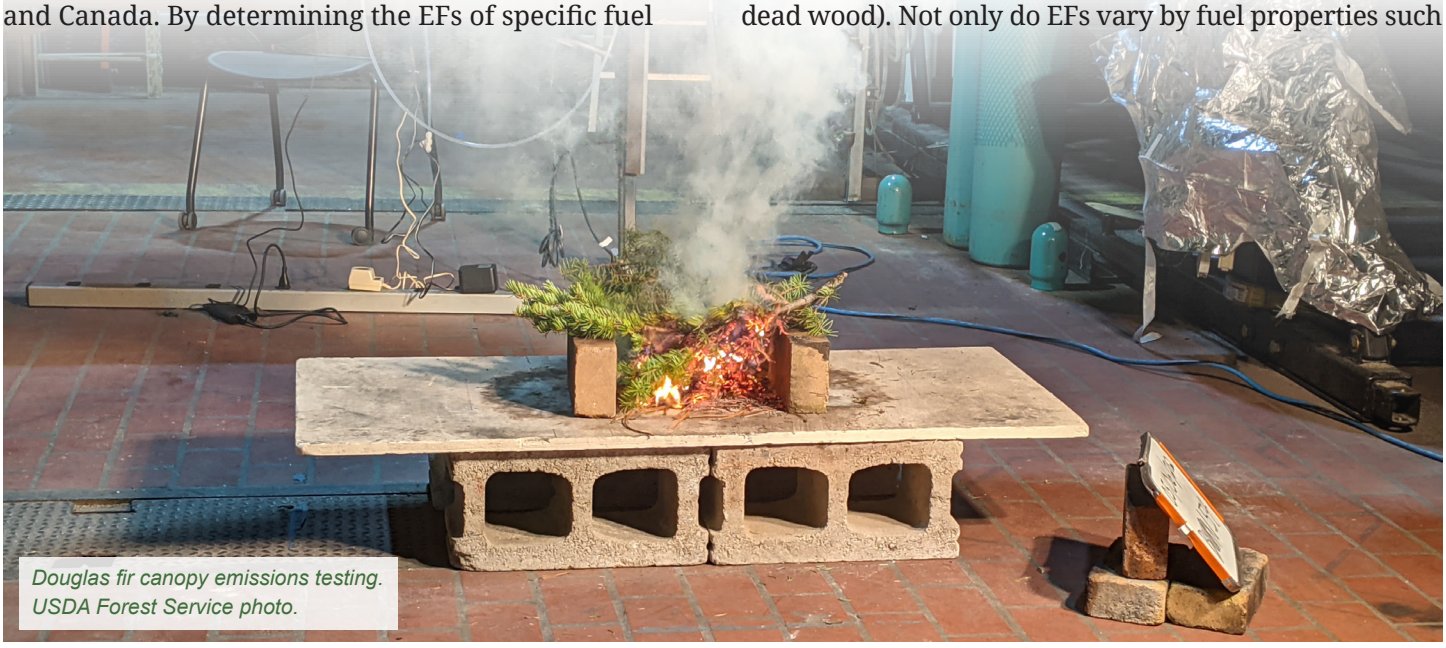
Wildfires have become more severe and have burned larger swaths of the western United States and Canada in recent decades. The smoke from these wildfires contains hundreds of different gases and aerosols, which have significant negative impacts on air quality, climate, and public health.

One way to combat potential future fires is through prescribed burning, but the smoke from these fires also pose a risk and nuisance to nearby communities.

To better understand the relative abundance of smoke pollutants, known as emission factors (EFs), Rocky Mountain Research Station research physical scientist Shawn Urbanski and chemist Emily Lincoln set out to measure the EFs from Douglas fir, ponderosa pine, and black spruce/jack pine forest fuels. These forest fuels account for a large share of burned area and smoke produced by wildfires in the western United States and Canada. By determining the EFs of specific fuel types, wildland fire managers can better understand and manage the smoke produced in both wildfires and prescribed fires. Before this study, EFs for some of these fuel types had never been calculated before, leaving a critical gap in understanding and quantifying the pollutants in smoke.

"They're really important data gaps that need to be filled in order to really come up with a robust or even a defensible estimate of what differences might be in emissions when one compares a wildfire versus a prescribed fire," said Urbanski.

In lab experiments, Urbanski, Lincoln, and collaborators measured smoke contents while burning the three forest fuel types, which were sampled from the forest floor and the canopy. Fuels included litter, sticks, and fresh canopy fuels. This particular study tested fuel particle size and shape (cones, needles, conifer boughs, 1 and 10 hr. fine dead wood). Not only do EFs vary by fuel properties such



Douglas fir canopy emissions testing. USDA Forest Service photo.

as fuel size, shape, packing, and moisture content, they also vary by fire behavior and intensity.

One way to reduce the concerns over smoke from prescribed burning is to improve smoke prediction tools, which rely on EFs. Public health officials, air quality forecasters, and fire management teams rely on smoke forecasting systems to mitigate the impacts of wildland fire smoke on public health and safety.

The new EFs described in this study can be modified into prescribed fire-specific EFs, which will improve smoke modeling tools and the understanding of how specific prescribed fires may impact air quality and emissions. Smoke scientists and fire managers will then be able to compare emissions from prescribed fire with potential future wildfires to be better informed when making fire and land management decisions.

The fuel component specific EFs measured in this study may be combined with those from previous studies to provide more accurate estimates of pollutant emissions from prescribed burns and wildfires. As an example, we used fuel consumption calculated by the First Order Fire Effects model for interior Douglas-fir forest to compare prescribed fire and wildfire emissions. Using the older EF formulation, particulate matter emissions (per an acre burned) for prescribed fire are 60% lower than a high intensity wildfire. However, using fuel component specific EFs based on our study we estimate prescribed fire particulate matter emissions are 90% lower than a high intensity wildfire.

Urbanski hopes to close remaining data gaps by expanding the study to include longer smoldering fuels like peat and coarse woody debris (greater than 3 inches in diameter) or even a full log.

Black spruce litter and fine woody debris fuelbed prepared for testing. USDA Forest Service photo.

KEY MANAGEMENT CONSIDERATIONS

- New emission factors (EFs) for Douglas fir, ponderosa pine, and black spruce/jack pine fuels fill a data gap in EF inventories used in many smoke prediction tools.
- Improved smoke predictions can be used to improve public health response, potentially allowing for more prescribed fires.
- New EF measurements will enable managers and researchers to compare potential smoke impacts of prescribed fires with possible future wildfires.
- Using fuel component specific EFs based on this study, prescribed fire particulate matter emissions can be 90% lower compared to a high intensity wildfire.

FEATURED SCIENTISTS

Shawn Urbanski is a research physical scientist with the Rocky Mountain Research Station. His research includes characterizing the gas and particulate emissions of wildland fires, designing wildfire emission inventories, developing tools for smoke modeling systems, and evaluating fire smoke sensors.

Emily Lincoln is a chemist with the Rocky Mountain Research Station. As part of the Fire, Fuel, and Smoke Program (FFS) she conducts national and international wildland fire research.

FURTHER READING

Urbanski, Shawn P.; Long, Russell W.; Halliday, Hannah; Lincoln, Emily N.; Habel, Andrew; Landis, Matthew S. 2022. Fuel layer specific pollutant emission factors for fire prone forest ecosystems of the western U.S. and Canada. Atmospheric Environment: X. 16: 100188.

Urbanski, Shawn P.; O Neill, Susan M.; Holder, Amara L.; Green, Sarah A.; Graw, Rick L. 2022. Emissions. In: Peterson, David L.; McCaffrey, Sarah M.; Patel-Weynand, Toral, eds. 2022. Wildland fire smoke in the United States: A scientific assessment. Cham, Switzerland: Springer Nature Switzerland AG. 121–165. Chapter 5.

The Rocky Mountain Research Station is one of seven units within USDA Forest Service Research & Development. RMRS maintains 14 field laboratories throughout a 12-state geography encompassing parts of the Great Basin, Southwest, Rocky Mountains, and the Great Plains. While anchored in the geography of the West, our research is global in scale. RMRS also administers and conducts research on 14 experimental forests, ranges and watersheds and maintains long-term research databases for these areas. Our science improves lives and landscapes. More information about Forest Service research in the Rocky Mountain Region can be found here: https://www.fs.usda.gov/research/rmrs/.