TECHNICAL BRIEF

A Strategic Research Initiative on the Characterization of Atmospheric Contributions of Wildland Urban Interface Fire Emissions

Introduction

Wildfires are becoming more common due to a changing climate, longer fire seasons, and the buildup of dry fuels. Also, a growing number of homes in the wildland urban interface (WUI) puts more people in danger of being near a wildfire and/or exposed to dangerous smoke conditions. There are more than 60,000 WUI communities at risk in the U.S. where structure fuel from the built environment can meet wildland vegetation during a fire.[1] WUI fires may occur in nearly every part of the U.S. and WUI/wildfire smoke can travel long distances affecting millions of people outside the initially impacted area.

WUI/wildfire smoke is a global public health issue since it can contain particulate matter (PM) and a wide variety of chemical pollutants, including organic gases such as volatile organic compounds (VOCs) and inorganic gas-phase metals. Exposure to 2.5 microns and smaller ($PM_{2.5}$) fine particulate matter is especially hazardous since these particles can penetrate deep into the lungs and potentially enter the bloodstream. This exposure can lead to health concerns including eye and throat irritation, coughing and shortness of breath, and asthma attacks. Longer term exposure can lead to cardiovascular disease and even premature death. Children, the elderly, and those with pre-existing conditions like chronic obstructive pulmonary disease are especially vulnerable.[2] Although some toxicity data is available on both wildland and structural fire emissions, there is a recognized data gap related to the characterization of emissions from WUI fires.[3] Thus, the risks of exposure to WUI fire emissions represents a public health challenge since their impact on the health of workers, first responders and the general population cannot be properly determined unless these emissions are well characterized. The purpose of this research initiative is to characterize the chemical and particle composition of potential WUI fire emissions using a laboratory scale system. This provides a first step toward understanding health impacts resulting from WUI smoke exposure.

Study Objectives

The overall objective of this study is to use a laboratory scale combustion generation system to identify particle and chemical emission profiles of mixed synthetic and biomass fuels that represent built environment materials and a variety of geographically relevant wildland fuels. Specific research goals are to:

- Characterize emissions from combustion of source samples made from wildland fuel from four specific regions in the United States – Northeast, Northwest, Southeast, and Southwest.
- Characterize emissions from combustion of source samples with wildland fuel also containing synthetic materials from built environment construction materials.

Study Plan Overview

The study objectives will be met using the following sampling and analysis plan:

1. Source samples for combustion will be fabricated using representative wood samples from four U.S. geographic regions as follows:
   - **Northeast** – Red Oak
   - **Northwest** – Douglas Fir
   - **Southeast** – Ponderosa Pine
   - **Southwest** - Loblolly Pine
2. Source samples for combustion will be fabricated using representative wood samples listed above for each region with the addition of synthetic building materials.
   - **Synthetic 1** – Structural medium density fiberboard (MDF)
   - **Synthetic 2** – Structural foam insulation
   - **Synthetic 3** - Painted interior wall board

Source samples will be prepared as test pellets for combustion. The pellets will be formulated in the following combinations to represent typical WUI fire fuel sources. The goal is to provide combustion data on mixtures of modern building materials and biomass fuels from across the U.S.

Wood Source	Mixture 1	Mixture 2	Mixture 3	Mixture 4
Northeast	Wood + synthetic 1	Wood + synthetic 2	Wood + synthetic 3	Wood + synthetics 1,2,3
Northwest	Wood + synthetic 1	Wood + synthetic 2	Wood + synthetic 3	Wood + synthetics 1,2,3
Southeast	Wood + synthetic 1	Wood + synthetic 2	Wood + synthetic 3	Wood + synthetics 1,2,3
Southwest	Wood + synthetic 1	Wood + synthetic 2	Wood + synthetic 3	Wood + synthetics 1,2,3

3. Combustion experiments will be conducted using a laboratory scale combustion chamber fitted with integrated comprehensive emission sampling and analysis instrumentation.
4. Particle and chemical characterization will be done on emissions from combustion experiments to determine particle size distribution, total VOCs analyzed by photoionization detection (PID), individual VOCs, aldehydes, and polycyclic aromatic hydrocarbons (PAHs) analyzed by gas chromatography-mass spectrometry (GC-MS), morphological assessment of metals and oxides using scanning electron microscopy (SEM) and transmission electron microscopy (TEM), gas speciation and quantification of identified gases and collection of particulate samples to be analyzed by inductively coupled plasma mass spectrometry (ICP-MS) for identification of metals.

REFERENCES:

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Scientific Outcomes

01

Development of a laboratory scale methodology for generating regionally representative fuel source samples for combustion studies.

02

Development of a laboratory scale methodology for incorporation of building construction materials into fuel source samples for combustion studies.

03

Evaluation and comparison of particle and chemical characterization of combustion emissions from both wood-based, and synthetic material/wood-based fuel sources.

04

Identification and concentration estimates of particle and chemical burn emissions from known wildland and construction material fuel sources.

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