Abstract

VOCs and Wildfire Flashovers †

Rawaa Jamaladdeen *, Bruno Coudour, Hui-Ying Wang and Jean-Pierre Garo

Institut Pprime, 86073 Poitiers, France
* Correspondence: rawaa.jamaladdeen@ensma.fr
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Flashover phenomena in wildfires have been reported by firefighters and have caused a number of fatalities among their ranks. While approaching a confined topography, such as a canyon or a thalweg, some wildfires, which initially seem to be predictable, exhibit a sudden eruption with an increased rate of spread and temperature. Flashovers refer to the potential ignition of flammable gas pockets formed in confined topographies with concentrations exceeding their lower flammability limits (LFLs). The origin of these accumulations is strongly related to the emissions of burnt and heated plants in the wildfire event, supported by the testimonies of firefighters who smelled strong Volatile Organic Compound (VOC) odors prior to the flashover. The controversy in this hypothesis was examined by our experimental and numerical works in order to investigate the evolution of the wildfire VOCs from emission to dispersion and the accumulation in confined topographies. Experimental works in a wind tunnel investigated the accumulation of a steady state injection of ethane gas in a forest model scaled at 1/400 incorporating a valley and subjected to downwind velocities of 6 m/s [1]. The experimental results confirmed boundary layer separation and circulatory velocity profiles with ethane accumulation in the lee side of the valley. A numerical steady state CFD model with STAR-CCM+ has been validated using experimental results to then incorporate a transient fire front model with unsteady flow rates of wildfire emissions based on the literature. The behavior of fire line intensity, rate of spread, and residence time were predicted using the Rothermel mathematical model. After a 100 min simulation, the results show that the highest gas concentrations are located on the lee side and that aromatics present in smoke are more concentrated than the methane inside the thalweg, even if methane is emitted ten times more at the fire front.

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