

Wildfire Modeling of Ember Behavior and Accumulation Patterns Around Homes

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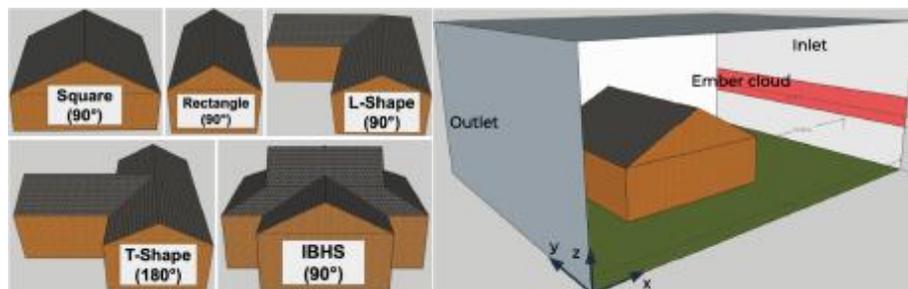
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Abstract

Wildfires can spread through direct flame contact, radiant heat transfer, or spotting of firebrands. Embers, or firebrands, form as a fuel structure degrades into smaller particles, and these particles can be lofted upward by the fire plume, where they become captured by wind. Embers are a particularly potent mechanism for wildfire propagation because the wind-driven particles can carry farther and faster than the actual flame front, thereby nullifying defensible zones. Fire lawmakers have defined Defensible Space Zones around residential buildings to minimize damage to homes during wildfires. This research covers regions from all zones, but contains more detailed analysis on Zones 0 and 1, which encompass the space 30 ft around the home.

The research analyzes ember accumulation for various building layouts and roof designs. This work initiates the simulation in a manner similar to a previous work leveraging Pyrosim and applies semi-realistic ember parameters to an ember storm over a variety of structure shapes to determine what simple design factors contribute to ember accumulation. The study tests various ember sizes, ember densities, wind speed in the horizontal and vertical direction, rooftop styles, and fire effects to examine how each factor impacts ember behavior.

This modeling work focuses on using PyroSim as a potentially powerful third-party tool by Thunderhead Engineering and is designed to complement the base CFD code, Fire Dynamics Simulator (FDS). FDS is a free software developed by National Institute of Standards and Technology (NIST). FDS is a large-eddy computational fluid dynamics (CFD) software model that predicts turbulent fire-driven fluid flow by solving time-dependent, three-dimensional flow fields using the Navier-Stokes equations. Typically FDS reads input parameters from a text file and outputs a numerical solution, but PyroSim offers a graphical interface that generates input parameters to FDS for the user.



Model home geometries and simulation setup