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Firebrand formation and transport, a critical mechanism of wildfire propagation

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Understanding the mechanisms by which wildfires spread is important for operational fire modeling, risk mapping, and the design of fire resilient communities. This is particularly important in the wildland-urban interface (WUI), where wildlands and communities directly interact with one another. In these areas, fires very often spread and ignite structures not due to the main fire front, but from “firebrand showers", which deposit numerous burning embers that sometimes ignite surrounding vegetation and homes. The firebrand shower is a complex multi-scale, multi-physics phenomenon consisting of three major phases: firebrand formation, lofting and downwind transport far ahead of the fire-front, and ignition of new spot fires upon landing. In the present work, a method is first proposed to study firebrand generation from burning vegetation, which has been used to understand the phenomenon and scale dominant processes. In addition, an experimentally validated, coupled stochastic parametric model of firebrand transport is developed which can be used to predict the spotting distribution from large wildland fires. The developed model and findings of this study are important not only for predicting and characterizing firebrand transport, but can also be used to study debris transport within other extreme events such as hurricanes.