Ember research: Smaller branches pack the fastest, biggest fire-spreading punch

December 5 2017

Ember research. Credit: Oregon State University

As the West tallies the damages from the 2017 wildfire season, researchers at Oregon State University are trying to learn more about how embers form and about the blaze-starting potential they carry.

Preliminary findings indicate the diameter of the branches that are burning is the biggest single factor behind which ones will form embers the most quickly and how much energy they'll pack.

"Increased population in the wildland-urban interface means increased risk to life and property from wildland fires," said Tyler Hudson, a graduate student in the College of Engineering. "Spot fires started by embers lofted ahead of the main fire front are difficult to predict and can jump defensible space around structures."

Research shows smaller-diameter branches are better at producing embers, also known as firebrands.

"Embers are wildfires' most challenging mode of causing spread," said David Blunck, assistant professor of mechanical engineering. "By understanding how embers form and travel through the air, scientists can more accurately predict how fire will spread. We have a multiscale approach that involves burning samples in a laboratory setting, larger burns - burning 10-foot-tall trees - and then working with the U.S. Forest Service to participate in prescribed burns."

In his lab, Blunck's research group controls multiple parameters which can influence generation rates: fire intensity, crosswind velocity, species of tree, diameter of the sample, fuel condition (natural vs. processed), and moisture content of the fuel.

"Fire intensity had little effect on the time needed for ember generation," Hudson said. "And natural samples and dowels with similar diameters can have quite different ember generation times."

Using samples of Douglas fir, western juniper, ponderosa pine and white oak with diameters of 2 and 6 millimeters, the researchers determined that 2-millimeter samples generated embers roughly five times as fast as 6-millimeter samples.

This trend can be explained by the observation that the bending stress is proportional to 1 divided by the cube of the diameter - thus, the larger the diameter, the smaller amount of bending stress and a lesser likelihood of breakage, and ember creation. Moreover, smaller diameters have less fuel that needs to be burned.

In the field, researchers can track embers' energy "from the time they leave the tree until they get to their destination," Hudson said, using techniques ranging from infrared videography to measuring scorch marks on squares of fire-resistant fabric placed on the ground at varying distances from the fire.

Blunck, Hudson and fellow mechanical engineering graduate student Mick Carter presented their preliminary findings in April at the 10th edition of the biennial U.S. National Combustion Meeting in College Park, Maryland.

In August, Blunck was among a group of collaborators receiving a $500,000 grant from the National Institute of Standards and Technology "for the development of a computer model that will define patterns for firebrand distribution during wildland-urban interface fires and their likelihood of igniting nearby structures."

This past fire season in Oregon, roughly 2,000 fires combined to burn more than a half-million acres - that's about 1,000 square miles, an area the size of Rhode Island.

One of the most devastating of those blazes was the Eagle Creek fire in the Columbia River Gorge, which scorched nearly 50,000 acres and threatened the historic Multnomah Falls Lodge - and provided a terrifying illustration of what embers can do.

"The fire jumped the river and started burning in Washington because of embers," Blunck said. "We estimate that the fire jumped 2 miles across the river."

Provided by Oregon State University