Tree species influence boreal forest fire behavior and subsequent effects on climate

February 2 2015

For a better understanding of how forest fires behave and interact with climate, scientists are turning to the trees. A new study out of UC Irvine shows that differences in individual tree species between Eurasia and North America alter the continental patterns of fire - and that blazes burning the hottest actually cool the climate.

"High-intensity canopy fires are prevalent in boreal North America, whereas lower-intensity surface fires are common in Eurasia," said Brendan Rogers, a UCI doctoral student now at Woods Hole Research Center in Massachusetts. "These differences have large-scale implications for fire ecology, climate modeling and forest management. Yet their patterns, consequences and underlying causes were not well understood."

Using remote sensing imagery, he and UCI Earth system science professors James Randerson and Michael Goulden found that conifer trees are the drivers - rather than the passive victims - of the types of fire that consume them.

In North America, for example, tree species known as "fire embracers" have evolved to both spread and be destroyed by fire. Mature stands of black spruce, which are ubiquitous in Canada and Alaska, burn like a torch and cause intense treetop fires that kill the canopy.

In Eurasia, on the other hand, the thick bark and sparse lower branches of "fire resisters" allow them to largely survive flames, which creep

along the forest floor consuming underbrush.

Each fire type results in different climate feedback over subsequent years, the study shows. The loss of leaves and branches from North American blazes exposes underlying snow and allows more sunlight to be reflected in spring months. This has a cooling effect on the climate. In Eurasian forests where tree cover remains relatively intact, this effect is much smaller. The overall impact of forest fires - including atmospheric warming from the released carbon dioxide - is thought to be neutral or warming.

Because the fire regime in Alaska and Canada is dominated by black spruce, Randerson said, "this study may document the single largest influence of individual species on global patterns of carbon and energy flows—apart from humans."

Understanding this phenomenon is important in developing accurate Earth system models used by scientists to study climate change. "Current global fire models neglect the influence of these species-level traits, thereby misrepresenting boreal fire dynamics and their associated feedbacks to climate warming," Rogers said. "We need to move beyond the use of generic representations of trees and use the information from our study to make informed decisions on how to manage these forest fires for climate mitigation."

Provided by University of California, Irvine