Extreme wildfires are turning the world's largest forest ecosystem from carbon sink into net-emitter

March 6 2023, by Tadas Nikonovas and Stefan H Doerr

Credit: AI-generated image (disclaimer)

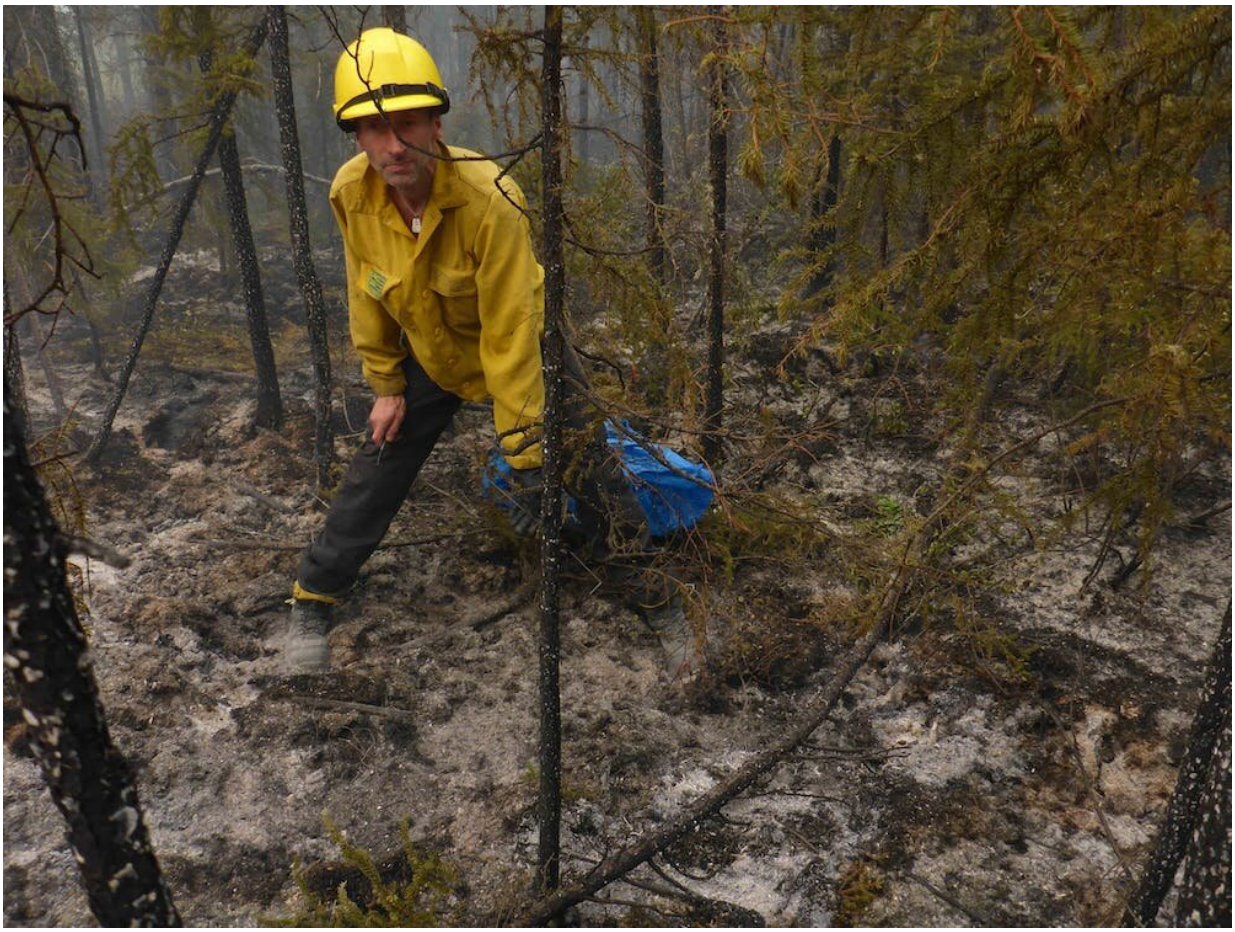
The vast boreal forests of the Northern Hemisphere stretch from Scandinavia through Siberia, Alaska and Canada. They cover a tenth of the world's land but hold one-third of the land's carbon, stored mainly in organic-rich soils and in trees. Now, a new study in the journal *Science*

provides further evidence that emissions from wildfires in high northern latitudes are already increasing at an alarming rate.

In these forests, the cold climate and often waterlogged ground means fallen tree bark, needles and other dead organic matter takes a long time to decompose. This has allowed the soils to accumulate carbon over thousands of years after the ice sheets retreated at the end of the last ice age. Since then, these ecosystems have mainly been shaped by wildfires ignited by lightning.

These fires release some of the carbon stored in trees and in the upper layer of soil back into the atmosphere. The release of soil carbon is hugely significant. It means a boreal forest fire will release 10 to 20 times more carbon compared to a similarly sized fire in other ecosystems where fires consume mainly vegetation and where the soil itself does not contain enough carbon to burn.

However, these boreal forests might burn only once a century, sometimes even less often than that. This is much longer than in most other fire-prone ecosystems, and the extra carbon stored in soils and trees in the long period between fires normally exceeds the losses from fires. For the past 6,000 or so years this delicate relationship between carbon uptake and release was quite stable and boreal forests served as a globally important carbon sink.



One of the authors investigates a wildfire in boreal Canada. Most of the carbon lost in this fire would have been from soil, not trees. Credit: Cristina Santin, Author provided

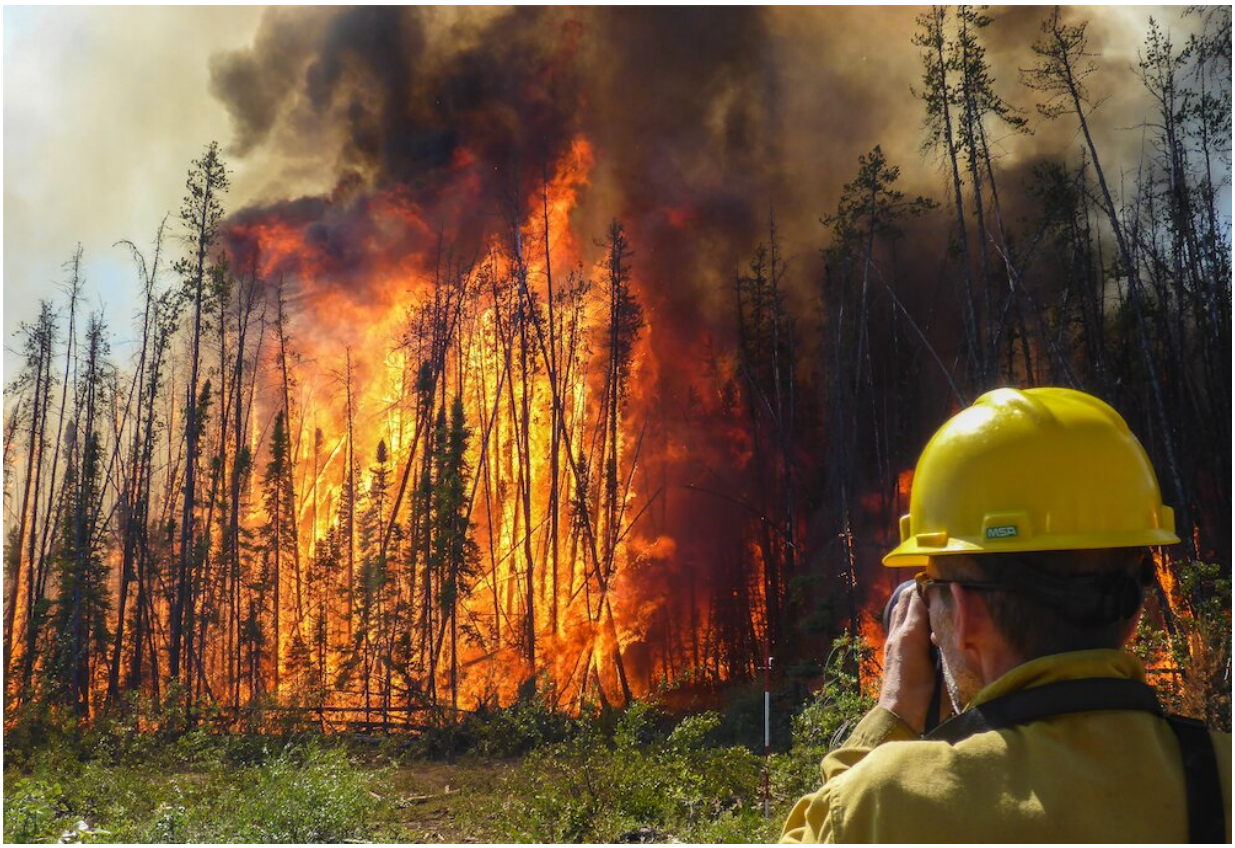
But global heating, which is particularly pronounced in the Northern Hemisphere's high latitudes, is threatening the balance. Soaring temperatures have lengthened the fire season and increased the frequency and severity of wildfires and there is growing evidence that as the interval between fires shortens, more carbon is being released from organic soils in boreal forests than the ecosystems can reabsorb.

Satellites can spot gas emitted by wildfires

That's where the latest study in *Science* comes in. The researchers, mostly based in China, used satellite observations of wildfire smoke plumes to look for carbon monoxide, which is invisible to the naked eye but shows up at certain infrared wavelengths. Carbon monoxide isn't itself a greenhouse gas, but if you know how much of it there is, you can infer the amount of carbon dioxide in wildfire smoke as well.

This contrasts with the more conventional methods employed by current wildfire emission models. These also use satellites, but record active fires or burned areas simply by comparing before and after images. They then factor in a range of assumptions on how much vegetation would typically have been consumed and how much carbon is emitted per area of different types of vegetation and soil burned.

While this new carbon monoxide method has its own uncertainties, it provides independent and more direct estimates of wildfire emissions. It also has potential to give us a more detailed understanding of the differences in wildfire carbon emissions between different ecosystems.



Fires like these are now releasing more carbon than is stored in the period in between. Credit: Cristina Santin, Author provided

A dramatic increase

The new study showed a significant increase in emissions from boreal fires over the past two decades. Things were particularly dramatic in 2021, when they comprised a record 23% of global vegetation wildfire emissions, more than twice their contribution in a more typical year.

If this trend continues, the boreal forest may very soon become the dominant source of global emissions from biomass burning, overtaking the notorious tropical peatland fires (such as those in Indonesia in 2015)

in terms of global significance and adding further to the "fire–carbon-climate warming" feedback.

The 2021 fire season was made particularly extreme by simultaneously hot and dry conditions both in North America and northern Europe and Asia. If such weather patterns do become more frequent, leading to more fires in the boreal region, these forests may reach a "wildfire tipping point." A study examining the extreme fires of 2014 in boreal north-west Canada demonstrated that some areas were already turning from carbon sinks into net emitters. This new study covering the entire boreal biome suggests this ecosystem as a whole—from Siberia to Canada—is rapidly approaching this tipping point.

Provided by The Conversation

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