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Forest Fires Can Heat Up the Whole Planet

A new NASA study aims to unravel the ways changes in boreal forests affect climate.



The [Suomi-NPP](#) satellite captured this image of active fires near Fort McMurray, Canada, in May 2016.

PHOTOGRAPH BY NASA EARTH OBSERVATORY

By **Laura Parker**

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A monster [forest fire](#) that began in early May is still burning in Canada's vast, isolated north woods. That may seem of little consequence to anyone other than the 88,000 residents of Fort McMurray forced to flee as the blaze swept into the northern Alberta city.

Yet large fires like these matter immensely to the rest of the planet.

Fires so intense that they consume millions of acres of trees and scorch the soil on the forest floor have become the kind of extreme disruptors that are remaking the [boreal forest](#) and transforming its role as one of the world's great protectors against global warming.

The [boreal](#), which takes its name from Boreas, the Greek god of the North Wind, encircles the top of the globe in North America and Eurasia. Half lies in Siberia, another third in Canada, and the rest in Alaska and Scandinavia.

It is Earth's single largest land habitat, and it stores about 30 percent of the carbon found on the planet's surfaces—more than any other terrestrial ecosystem. The forest also provides refuge for animals and birds as they relocate from southern habitats that have become too warm.





Climate change is playing out twice as fast in the boreal forest than it is on the rest of the planet. Permafrost is thawing, and vegetation is changing as climatic zones migrate north faster than trees can adapt.

Already, dramatic change can be glimpsed from space: The tundra is turning green, while the boreal forest is turning brown.

Some scientists predict the boreal forest may reach a disastrous—and irreversible—tipping point this century and shift from carbon storehouse into a major source of greenhouse gas emissions. Others contend that the tipping point has already been reached.

“These forests matter to the rest of us on Earth because of how they help regulate climate by keeping carbon in the soil and in the trees and out of the atmosphere,” says Peter Griffith, founding director of NASA’s Carbon Cycle and Ecosystems Office.

“So where fires are getting bigger and happening more often, that impacts the rest of us. It’s putting more greenhouse gases into the atmosphere that would have stayed locked up for perhaps hundreds of years.”

View From ABoVE

Griffith is director of the Arctic Boreal Vulnerability Experiment (ABoVE), a decade-long NASA study that is using satellite imagery to examine the impact of climate change on the Arctic tundra and boreal forests.

The region under NASA’s microscope spans 2.5 million square miles (6.4 million square kilometers). The project launched its first field research earlier this spring on nearly two dozen separate studies, which range from the changing migratory patterns of caribou and birds to the role of fire as a contributor to climate change.

Scott Goetz, deputy director and scientist at Woods Hole Research Center in Falmouth, Massachusetts, first documented the shifting colors of the tundra and boreal forest in 2005. The change happens as more vegetation grows in the warming Arctic, and forests struggle to survive against fire and insect infestations in warmer and drier conditions.





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For the NASA study, Goetz will continue to examine this change. The boreal is expanding in the north, he says, and declining in the southern region. Evergreen stands of conifers are being replaced by deciduous trees, larch, and birch or, in some places, by less productive grassland.

"That was a surprise, to see declining productivity," Goetz says of the struggle in the southern end of the forest. "Most think they would be greater and more productive, but warmer and drier is not conducive to productivity."

Another natural focus of the NASA study is thawing permafrost, which, when melted, would release a mother lode of stored carbon and methane into the atmosphere. That would create more warming, which would in turn create more thawing. It becomes a vicious cycle, known as positive feedback.

"Once you start thawing the permafrost out, you can't stop it. It's completely irreversible," says [Kevin Schaefer](#), a scientist at the University of Colorado's National Snow and Ice Data Center. "Once organic matter thaws out, even if the permafrost refroze, you can't put it back. It's a climatic tipping point."

Feeling the Burn

Now, as forest fires become more intense and frequent, they are creating a similar cycle. Large fires are not only killing all the trees, they are burning through the peat, the rich organic soil on the forest floor that serves as a large reservoir for carbon.

"The warmer the Earth gets, the more fire we get, and the more fire we get, the more greenhouse gases we get," says [Mike Flannigan](#), director of the Western Partnership for Wildland Fire Science at the University of Alberta in Edmonton.

Conditions are ripe for more frequent fires in multiple ways. For every degree of global warming, the forest needs a 15 percent increase in precipitation to compensate for the increased drying caused by warming, according to a recent study. Instead, forests are getting less rain, not more.

Scientists also have found that every degree of warming sets off a 12 percent increase in lightning activity, Flannigan says. In the woods, lightning means more forest fires.

Fires in Canada's huge, largely unpopulated forest often burn for months, and are extinguished by the first snow of autumn. Last summer, fires in the Northwest Territories burned more than 3.4 million acres (1.375 million hectares)—an area the

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size of Maryland.

So far, the Fort McMurray fire has burned more than 1.45 million acres (589,600 hectares) and is considered “held,” meaning it has stopped gaining in size but is still burning out of control. That could change if

the weather turns hot and windy.

Investigators believe the first blaze was caused by humans, although it’s unclear whether that was deliberate or accidental. At times, it burned with such intensity that it spawned its own thunderstorms, complete with lightning that ignited new fires within the fire.

“I have seen lightning before,” says Flannigan. “But spawning new fires? That is a new one for me.”

Up in Smoke

The Fort McMurray fire turned out to be exactly the large, intense fire that scientists in the NASA study want to examine, although it didn’t quite work out that way. [Brendan Rogers](#), an Earth scientist at the Woods Hole Research Center, is studying how deeply large fires burn the layers of peat on the forest floor.

“There have been a lot of studies about how climate affects fires,” he says. “We want to study how fire feedback affects climate.”

Earlier last spring, Rogers and a team of five scientists chose the forest zone around Fort McMurray for a smoke-measuring experiment, because the area rates high for fire severity. Smoke would help determine the age of the carbon being released, which could then be compared to soil samples.

“If you look at the smoke from these fires, you can look at the average of the carbon in that smoke, and since most comes from the soil, you can get an average of the burn depth,” he says.

Fire season begins earlier these days, but the team did not expect a blaze to break out in early May.

The team’s smoke sensors arrived in Fort McMurray the same day the city evacuated, and Rogers has not learned their fate. Some of the volunteers recruited to monitor the sensors lost their homes and are now preoccupied with rebuilding their lives.

“It would have been perfect, so it is ironic and also a bit scary,” he says. “You need to be close, but not too close. We didn’t expect one to happen right there in town.”

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