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# Peatlands, wildfire, and climate change in boreal North America

**M. R. Turetsky**

Department of Plant Biology, Michigan State University, USA (mrt@msu.edu)

Boreal regions contain large stocks of soil carbon, mostly in peatlands that accumulate thick organic soil layers. Peatlands clearly have served as an important reservoir for soil carbon on a millennial time scale. However, it is unknown whether these ecosystems globally will continue to represent a net carbon sink, or whether changes in the Earth's climate will cause peatlands to begin releasing stored carbon back to the atmosphere. Fire is widely regarded as an important process in regulating carbon cycling in boreal forests, where fire activity directly releases large amounts of carbon-based trace gases into the atmosphere in the forms of carbon dioxide, carbon monoxide, and methane. However, the implications of fire for carbon cycling in peatlands have received less attention.

As a result of recent climate change, the annual area burned in boreal North America has more than doubled since 1950, raising the question of whether the deep organic soils currently stored in peatlands are becoming more vulnerable to burning under these altered fire regimes. The Canadian Large Fire Database and peatland distribution maps have been used to explore patterns of burn area in peatlands across the provinces and territories of western Canada, representing about 40% of the Canadian land-base. Measurements of organic matter consumption have been made in a variety of natural and experimental fire events in both western Canada and Alaska to better understand vegetation and fire weather controls on carbon losses during burning. These data have been used in fire emissions models to estimate continental-scale emissions of carbon and mercury due to peat fires. Results to date demonstrate that large areas of peatlands in continental Canada can burn each year. The total burn area of large fire events (greater than about 1000 $km^2$ occurring between 1980 and 1999) is positively

correlated to the abundance of peatlands in western Canadian landscapes, suggesting that peatlands are particularly susceptibility to burning during large fire years and/or extreme fire weather conditions.

In the forested continental peatlands of western Canada, about 30% of soil carbon is situated above the regional water table in aerobic peat layers and is vulnerable to burning under current climate conditions. However, deeper peat layers will become increasingly exposed to fire under future climate regimes as these continental peatlands are subjected to regional changes in both fire weather and drought. Both empirical and modeling results demonstrate that drought conditions that lower regional water tables and/or increase fire severity in peatlands greatly exacerbate regional carbon emissions to the atmosphere. While peatlands in North America have served as a long-term carbon sink throughout the Holocene period, drier climatic scenarios that lead to altered fire regimes could accelerate fuel consumption rates and cause much of this organic matter to be released back to the atmosphere.