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Impact of wildfire on methane emissions at a continental boreal peatland

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Boreal peatlands represent a globally important store of carbon, and disturbances such as wildfire can have a significant positive feedback to the climate. Understanding how carbon cycling and greenhouse gas (GHG) dynamics are impacted after a wildfire is important, especially as boreal peatlands may be vulnerable to changes in wildfire regime under a rapidly changing climate. Yet given this vulnerability, there is very little in the literature on the impact such fires have on methane (CH_4) emissions.

This study investigated the effect of wildfire on CH_4 emissions at a boreal fen near Fort McMurray, AB, Canada, partially burned by the Horse River Wildfire in 2016. We measured CH_4 emissions and environmental variables (2017-2018) and CH_4 production potential (2018) in two different microform types (hummocks and hollows) across a burn severity gradient (unburned (UB), moderately burned (MB) and severely burned (SB)).

The average CH_4 flux at the UB hollows was 96.5 and 66.6 mg CH_4 m^{-2} d^{-1}in 2017 and 2018, respectively. Methane emissions were much lower in the MB and SB hollows in both years, with the average flux being 0.25 and 0.06 mg CH_4 $m^{-2}d^{-1}$ in 2017 and 1.93 and 1.38 mg CH_4m^{-2} d^{-1}, respectively. Interestingly, across the burned sites, hummocks had higher fluxes in 2017 than hollows with the average flux being 1.82 and 5.83 mg CH_4m^{-2} d^{-1} at the MB and SB sites, respectively. Results of a linear mixed effects model (LMM) illustrate there is a significant effect of burn severity on CH_4 flux, although no significant difference between microform or year. Another LMM found a significant interaction between burn severity and both soil temperature at 30 cm depth and water table. There was also significantly higher CH_4 production potential from the UB site than the burned sites.

The reduction in CH_4 emissions and production in the hollows at burned sites highlights the sensitivity of hollows to fire, removing labile organic material for potential methanogenesis. The previously demonstrated resilience of hummocks to fire also results in limited impact to methane emissions and likely faster recovery to pre-fire rates.