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Drivers of carbon emissions and active layer thickening from boreal wildfires in a continuous permafrost region of Northeast Siberia

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The circumpolar boreal biome is affected by increases in fire frequency and severity associated with climate warming. About 30% of the world's terrestrial carbon (C) is stored in the boreal region. Fires can produce large C emissions when substantial amounts of aboveground and belowground biomass and soil organic matter are combusted. Quantification and understanding of the drivers of C combustion is crucial to better assess the role of boreal fires in the global carbon cycle.

Despite the fact that the majority of boreal burned area occurs on the Eurasian continent, relatively few measurements of C combustion have been made in Eurasian boreal ecosystems. Here we synthetized data from 41 field sites collected during the summer of 2019 in Eastern Siberian larch forests. C combustion from surface and stand-replacing fires varied between 1.54 and 5.38 kg C/m^2. Belowground pools contributed in average to 73.9% of total C combustion. C combustion was higher in open larch-dominated forests (*Larix cajanderi*) and open forests with a mixture of larch and pine (*Pinus sylvestris*). High severity crown fires were observed in dense larch-dominated forests, yet C combustion was in average 23% lower than in the open stands. To our knowledge, this study is the first to quantify C combustion from wildfires in a continuous permafrost terrain in Northeast Siberia. We also investigated the effects of fire weather and pre-fire stand characteristics (e.g., stand age, drainage conditions, overstory tree species composition) on C combustion.

Because fires can also have a longer-term impact on permafrost environments through changes in surface energy balance and ground thermal regime, we also quantified active layer deepening in our study area. We measured thaw depth in 13 burned and 6 unburned sites one year after the fire. We explored the interactions between fire, vegetation, drainage conditions, and thaw depth. Our study shows that fire deepens the active layer, yet the magnitude of the effect is controlled by

vegetation characteristics and topo-edaphic factors. Our findings provide insight to feedbacks between climate warming and boreal fires in permafrost-underlain larch forests in Siberia.