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Expansion of wildfires and their impact on carbon emissions over pan-Arctic permafrost

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Wildfires over permafrost put perennially frozen carbon at risk. However, burned area and wildfire carbon emissions from biomass burning over the diverse range of permafrost regions have not been revealed. Here, we show that continuous permafrost was a major contribution to wildfire expansion and carbon emission in the pan-Arctic over the last two decades. Burned area and wildfire carbon emissions dramatically increased over continuous permafrost during the last two decades, but decreased in other permafrost regions. Accelerating wildfire emission from continuous permafrost region is the single largest contribution to the increased emissions in northern permafrost regions. The share of permafrost in global wildfire CO₂ emissions grew from 2.42% in 1997 to 20.86% in 2021. Wildfire expansion is closely linked to an increased soil moisture deficit, considering wildfires there combust more than 90% of belowground fuel. Continuous permafrost experiences more severe fire-induced degradation. Active layer thickening following wildfires over continuous permafrost lasts more than three decades to reach a maximum of more than triple the pre-fire thickness. These findings highlight expansion of wildfires and acceleration of fire-induced carbon emission from continuous permafrost region, which disturbs organic carbon stock, accelerates the positive feedback between permafrost degradation and climate warming.