Permafrost aggradation reduces peatland methane fluxes during the Holocene

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Methane emissions from northern high latitude wetlands are one of the largest natural sources of atmospheric methane, contributing an estimated 20% of the natural terrestrial methane emissions to the atmosphere. Methane fluxes vary among wetland types and are generally higher in peatlands, wetlands with $>$ 40 cm of organic soil, than in wetlands with mineral soils. However, permafrost aggradation in peatlands reduces methane fluxes through the drying of the peat surface, which can decrease both methane production and increase methane oxidation within the peat. We reconstruct methane emissions from peatlands during the Holocene using a synthesis of peatland environmental classes determined from plant macrofossil records in peat cores from $>$ 250 sites across the pan-arctic. We find methane emissions from peatlands decreased by 20% during the Little Ice Age due to the aggradation of permafrost within peatlands during this period. These bottom-up estimates of methane emissions for the present day are in agreement with other regional estimates and are significantly lower than the peak in peatland methane emissions 1300 years before present. Our results indicate that methane emissions from high latitude wetlands have been an important contributor to atmospheric methane concentrations during the Holocene and will likely change in the future with permafrost thaw.