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Methane emissions from high-latitude peatlands during the Holocene from a synthesis of peatland records

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The sources of atmospheric methane (CH₄) during the Holocene remain widely debated, including the role of high latitude wetland and peatland expansion and fen-to-bog transitions. We reconstructed CH₄ emissions from northern peatlands from 13,000 before present (BP) to present using an empirical model based on observations of peat initiation (>3600 ¹⁴C dates), peatland type (>250 peat cores), and contemporary CH₄ emissions in order to explore the effects of changes in wetland type and peatland expansion on CH₄ emissions over the end of the late glacial and the Holocene. We find that fen area increased steadily before 8000 BP as fens formed in major wetland complexes. After 8000 BP, new fen formation continued but widespread peatland succession (to bogs) and permafrost aggradation occurred. Reconstructed CH₄ emissions from peatlands increased rapidly between 10,600 BP and 6900 BP due to fen formation and expansion. Emissions stabilized after 5000 BP at 42 ± 25 Tg CH₄ y⁻¹ as high-emitting fens transitioned to lower-emitting bogs and permafrost peatlands. Widespread permafrost formation in northern peatlands after 1000 BP led to drier and colder soils which decreased CH₄ emissions by 20% to 34 ± 21 Tg y⁻¹ by the present day.