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Surface water salinization increases methane production in quaking fen peat

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Rising sea levels will increase the salinization of freshwater wetland ecosystems, especially affecting coastal peatlands and below-sea-level regions such as the Netherlands. Over 30% of the world's soil organic carbon is stored in peatlands, and this carbon is vulnerable to decomposition, consequently releasing greenhouse gases such as carbon dioxide (CO_2) and methane (CH_4). Therefore, the formation of new peat as quaking fens is key to carbon sequestration in these systems. A knowledge gap remains regarding how salinization affects microbial activity, biogeochemical processes, peat formation, and carbon accumulation in quaking fens. Quaking fens are in direct contact with surface water and therefore the first to be affected by increased salinization. This is especially relevant since recent evidence suggests that quaking fens are among the highest CH_4 emitters, yet the effects of increased salinization remain unknown. In this field- and laboratory-based study, we aimed to identify key conditions driving microbial CH_4 cycling in quaking fens. This involved geochemical analysis of the sediment and porewater, qPCR analysis of pmoA (aerobic methanotrophy) and mcrA (anaerobic methanotrophy and methanogenesis), as well as 16S rRNA amplicon sequencing. Additionally, the activity of methanotrophs and methanogens was studied via microcosm incubation experiments. The results revealed a higher abundance of carbon and organic matter in the porewater of the quaking fen compared to the deeper layers. This increased methanogenesis, which was up to 2.5 times higher in the brackish compared to the freshwater quaking fen. Furthermore, there was no indication that aerobic and anaerobic methanotrophy were notably influenced by salinization. This suggests that the high CH_4 release originates from increased methanogenesis rather than a decrease in methanotrophy in brackish quaking fens. Ultimately, this research will contribute to filling current knowledge gaps on the effects of salinization of freshwater peatlands on carbon biogeochemistry.