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Holocene carbon dynamics and radiative forcing of three different types of peatlands in Finland

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Peatlands contain approximately a third of all soil carbon globally and as they exchange carbon dioxide (CO_2) and methane (CH_4) copiously with the atmosphere, changes in peatland carbon budgets have a large impact on the global carbon balance and the concentration of greenhouse gasses in the atmosphere. There has been a growing interest in reconstructing and linking peatland carbon dynamics to past climate variations, because quantitative reconstructions can be used as a basis for future carbon balance predictions. In order to increase our understanding on peatland development and response patterns we quantitatively reconstructed Holocene carbon dynamics of three different peatlands in Finland: a subarctic fen, a boreal peatland complex and a boreal managed pine bog. Several cores from each peatland were investigated. The peatlands showed distinct successional pathways, which were sometimes triggered by fires. Successional stages were partly reflected in carbon accumulation patterns. Sometimes variations in carbon accumulation rates coincided with autogenic changes in peat type and vegetation, but accumulation rates were also related to the large-scale Holocene climate phases. However, Holocene climate changes as such did not seem to result in changes in the peat plant species composition. The mid-Holocene warm and dry climate conditions reduced the carbon accumulation in the subarctic fen and in the fen part of the boreal peatland complex, but when the peatland was in bog phase this effect was not visible. Some bog cores showed a clear increase in carbon accumulation after fen-bog transition, but the pattern was not unanimous. In addition to carbon accumulation, we estimated past CH_4 emissions for each peatland respectively by applying different methods and by utilising the established current vegetation-CH_4 emission relationship. The reconstructions showed that CH_4 emissions always decreased during bog stages, but that the CH_4 emissions played a major role in the total carbon budget of the peatlands throughout the Holocene. We combined the long-term effect of carbon accumulation and CH_4 emission and modelled Holocene atmospheric radiative forcing. The radiative forcing models show that these peatlands had a warming effect on the atmosphere for the first 1 to 2 thousand years since peat accumulation started, after which they had an increasing cooling effect as a result of the long term effect of uptake and storage of CO_2.