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Long-term GHG measurements at a northern boreal fen show stable CH4 emissions, increasing soil respiration and endangered carbon uptake as climate is warming

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Climate warming is strongest at the high northern latitudes. As peatlands store a vast amount of carbon in the form of peat, their response to warming is of particular interest. Peatlands contribute to atmospheric carbon dioxide (CO_2) and methane (CH4) concentrations by fixing CO_2 in photosynthesis and releasing it through respiration by plants and dead peat material, and by emitting CH4. As climate warming impacts these processes differently, long-term monitoring of both gases is essential to predict the behaviour of the peatland ecosystems and their carbon store in the future. Here we will present a ten-year (2007-2016) data set of CH4 and CO_2 exchange fluxes of a northern boreal fen measured with the eddy covariance method. The site, 'Lompolojänkkä' is located in Finland within the Pallas area (67°59.832'N, 24°12.551'E, 269 m above sea level) 160 km north of the Arctic Circle. Within this area the mean annual average temperature has increased by 2 °C in 40 years. Our results show that the gross primary production and annual CH4 balances have neither increased nor decreased during the last 10 years. However, the total ecosystem respiration shows an increasing trend, and consequently the annual net CO_2 uptake has decreased during the 10-year study period. The strongest warming has occurred in autumn, which has increased the net CO_2 emission during this period. During winter, spring and early summer, no changes in gas balances were observed. During the most recent warm years, the carbon balance, i.e. the sum of CO_2 and CH4 exchange, was close to zero. Thus our results suggest that climate warming decreases the net CO_2 uptake of a boreal fen through increased ecosystem respiration, while CH4 emissions stay unchanged.