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Eddy covariance flux measurements of net ecosystem carbon dioxide exchange from a lowland peatland flux tower network in England and Wales

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Peatlands store disproportionately large amounts of soil carbon relative to other terrestrial ecosystems. Over recent decades, the large amount of carbon stored as peat has proved vulnerable to a range of land use pressures as well as the increasing impacts of climate change. In temperate Europe and elsewhere, large tracts of lowland peatland have been drained and converted to agricultural land use. Such changes have resulted in widespread losses of lowland peatland habitat, land subsidence across extensive areas and the transfer of historically accumulated soil carbon to the atmosphere as carbon dioxide (CO_2). More recently, there has been growth in activities aiming to reduce these impacts through improved land management and peatland restoration. Despite a long history of productive land use and management, the magnitude and controls on greenhouse gas emissions from lowland peatland environments remain poorly quantified.

Here, results of surface-atmosphere measurements of net ecosystem CO_2 exchange (NEE) from a network of seven eddy covariance (EC) flux towers located at a range of lowland peatland ecosystems across the United Kingdom (UK) are presented. This spatially-dense peatland flux tower network forms part of a wider observation programme aiming to quantify carbon, water and greenhouse gas balances for lowland peatlands across the UK. EC measurements totalling over seventeen site years were obtained at sites exhibiting large differences in vegetation cover, hydrological functioning and land management.

The sites in the network show remarkable spatial and temporal variability in NEE. Across sites, annual NEE ranged from a net sink of -194 $\pm$38 g CO_2-C m-2 yr-1 to a net source of 784$\pm$70 g CO_2-C m-2 yr-1. The results suggest that semi-natural sites remain net sinks for atmospheric CO_2. Sites that are drained for intensive agricultural production range from a small net sink to the largest observed source for atmospheric CO_2 within the flux tower network. Extensively managed grassland and a site that was restored from intensive arable land use represent modest CO_2 sources. Temporal variations in CO_2 fluxes at sites with permanent vegetation cover are coupled to seasonal and interannual variations in weather conditions and phenology. The type of crop produced and agricultural management drive large temporal differences in the CO_2 fluxes of croplands on drained lowland peat soils. The main environmental controls on the spatial and temporal variations in CO_2 exchange processes will be discussed.