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Vegetation, soil property and climatic controls over greenhouse gas fluxes in a blanket peatland hosting a wind farm

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Peatlands are important carbon (C) stores, with boreal and subarctic peatlands containing 15-30 % of the world soil carbon stock (Limpens et al., 2008). Research has demonstrated that greenhouse gas (GHG) fluxes in peatlands are influenced by vegetation, soil property and climatic variables, including plant functional type (PFT), water table height and temperature. In this paper we present data from Black Law Wind Farm, Scotland, where we examined the effect of a predicted wind turbine-induced microclimatic gradient and PFT on carbon dioxide (CO_2) and methane (CH4) fluxes. Moreover, we determined the role of vegetation, soil property and climatic variables as predictors of the variation in CO_2 and CH4 emissions.

We measured CO_2 and CH4 at 48 plots within Black Law Wind Farm at monthly intervals from May 2011 to April 2012. Four sampling sites were located along a predicted wind turbine-induced microclimatic gradient. At each site four blocks were established, each with plots in areas dominated by mosses, sedges and shrubs. Plant biomass and PFT (vegetation factors); soil moisture, water table height, peat depth, C content, nitrogen (N) content and C:N (soil properties); and soil temperature and photosynthetically active radiation (PAR) (climatic variables) were measured. Analysis of variance (ANOVA) models based on the microclimatic gradient site, PFT and season when measurements were made explained 58 %, 44 % and 49 % of the variation in ecosystem respiration, photosynthesis and CH4, respectively. Site, PFT, season and their interactions were all significant for respiration and photosynthesis (with the exception of the PFT*site interaction) but for CH4 only the main effects were significant. Parsimonious ANOVA models using the biotic, soil property and climatic explanatory data explained 62 %, 55 % and 49 % of the variation in respiration, photosynthesis and CH4, respectively.

Published studies (Baidya Roy and Traiteur 2010; Zhou et al., 2012) and preliminary results from this study suggest that a wind turbine-induced microclimatic effect may exist. Consequently, given that the climatic variables, factors influenced by changes in the climate, and their interactions affect GHG fluxes, the operational effects of wind farms on peatland ecosystems may need to be taken into account when considering their full life cycle carbon budget.

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