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A 12-year record reveals pre-growing season temperature and water table level threshold effects on the net carbon dioxide uptake in a boreal fen

Matthias Peichl (1), Mats Öquist (1), Mikaell Ottosson-Löfvenius (1), Ulrik Ilstedt (1), Jörgen Sagerfors (1), Achim Grelle (2), Anders Lindroth (3), and Mats Nilsson (1)

(1) Department of Forest Ecology & Management, Swedish University of Agricultural Sciences, Umeå, Sweden (matthias.peichl@slu.se), (2) Department for Ecology and Environmental Research, Swedish University of Agricultural Sciences, Uppsala, Sweden, (3) Department of Physical Geography and Ecosystems Analysis, University of Lund, Lund, Sweden

This study uses a 12-year time series (2001-2012) of eddy covariance measurements to investigate the long-term net ecosystem exchange (NEE) of carbon dioxide (CO_2) and inter-annual variations in relation to abiotic drivers in a boreal fen in Northern Sweden. The peatland was a sink for atmospheric CO_2 in each of the twelve study years with a 12-year average ($\pm$ standard deviation) NEE of -58 $\pm$ 21 g C m-2 y-1. For ten out of twelve years, the cumulative annual NEE was within a range of -42 to -79 g C m-2 y-1 suggesting a general state of resilience of NEE to moderate inter-annual climate variations. In two years however, the annual NEE diverged considerably from this common range with -18 and -106 g C m-2 y-1 measured in 2006 and 2008, respectively. The lower annual CO_2 uptake in 2006 was mainly due to late summer emissions related to an exceptional drop in water table level. A positive relationship (r2 = 0.65) between pre-growing season (January to April) air temperature and summer (June to July) gross ecosystem production (GEP) was observed. We suggest that enhanced GEP due to mild pre-growing season air temperature in combination with air temperature constraints on ecosystem respiration (ER) during the following cooler summer explained the greater net CO_2 uptake in 2008. Differences in the annual and growing season means of other abiotic variables (e.g. radiation, vapor pressure deficit, precipitation) and growing season properties (i.e. start date, end date, length) were unable to explain the inter-annual variations of NEE. Overall, our findings suggest that this boreal fen acts as a persistent contemporary sink for atmospheric CO_2 that is however susceptible to severe anomalies in water table level and pre-growing season air temperature associated with predicted changes in climate patterns for the boreal region.