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Can continental bogs withstand the pressures from climate change?

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Not all peatlands are alike. Theoretical and process based models suggest that ombrogenic, oligotrophic peatlands can withstand the pressures due to climate change because of the feedbacks among ecosystem production, decomposition and water storage. Although there have been many inductive explanations inferring from paleo-records, there is a lack of deductive empirical tests of the models predictions of these systems' stability and there are few records of the changes in the net ecosystem carbon balance (NECB) of peatlands that are long enough to examine the dynamics of the NECB in relation to climate variability. Continuous measurements of all the components of the NECB and the associated general climatic and environmental conditions have been made at the Mer Bleue (MB) peatland, a large, 28 km2, 5 m deep, raised ombro-oligotrophic, shrub and Sphagnum covered bog, near Ottawa, Canada from May 1, 1998 until the present. The sixteen-year daily CO_2, CH4, and DOC flux and NECB covers a wide range of variability in peatland water storage from very dry to very wet growing seasons. We used the MB data to test the extent of MB peatland's stability and the strength of the underlying key feedback between the NECB and changes in water storage projected by the models. In 2007 we published a six-year (1999-2004) net ecosystem carbon balance (NECB) for MB of $\sim$22 $\pm$ 40 g C m-2 yr-1, but we have since recalculated the 1998-2004 NECB to be 32 $\pm$ 40 g C m-2 yr-1 based on a reanalyzed average NEP of 51 $\pm$ 41 g C m-2 yr-1. Over the same period the net loss of C via the CH4 and DOC fluxes were -4 $\pm$ 1 and -15 $\pm$ 3 g C m-2 yr-1. The 1998-2004 six-year MB average NECB is similar to the long-term C accumulation rate, estimated from MB peat cores, for the last 3,000 years. The post 2004 MB NEP has increased to an average of $\sim$96 $\pm$ 32 g C m-2 yr-1 largely to there being generally wetter growing seasons. The losses of C via DOC (18 $\pm$ 1 g C m-2 yr-1) and CH4 (7 $\pm$ 4 g C m-2 yr-1) while showing considerable year-to-year variability are not significantly different post 2004. Hence, the proportional loss of C as DOC and CH4 in the MB NECB is slightly less post-2004 than it was before 2004 though the cumulative errors preclude statistically differences. As a result the MB NECB has increased to 79 $\pm$ 29 g C m-2 yr-1 post 2004 yielding a 14 year contemporary NECB of 56 $\pm$ 36 g C m-2 yr-1, which is double the long-term accumulation rate of C. The variability in the annual NECB and growing season mean NEP for the MB bog can be explained ($r2 = 0.35$, $p < 0.01$) by the variability in growing season water table depth. These results suggest the carbon balance – water table feedback is sufficient enough to create stability in continental bogs so they will withstand a considerable amount of climate change.