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Nutrient load can lead to enhanced CH4 fluxes through changes in vegetation, peat surface elevation and water table depth in ombrotrophic bog

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Atmospheric nitrogen (N) deposition has led to nutrient enrichment in wetlands, particularly in temperate areas, affecting plant community composition, carbon (C) cycling, and microbial dynamics. It is vital to understand the temporal scales and mechanisms of the changes, because peatlands are long-term sinks of C, but sources of methane (CH4), an important greenhouse gas. Rainwater fed (ombrotrophic) bogs are considered to be vulnerable to nutrient loading due to their natural nutrient poor status. We fertilized Mer Bleue Bog, a Sphagnum moss and evergreen shrub-dominated ombrotrophic bog near Ottawa, Ontario, now for 11-16 years with N (NO_3 NH4) at 0.6, 3.2, and 6.4 g N m-2 y-1 ($\sim$5, 10 and 20 times ambient N deposition during summer months) with and without phosphorus (P) and potassium (K). Treatments were applied to triplicate plots (3 x 3 m) from May – August 2000-2015 and control plots received distilled water. We measured CH4 fluxes with static chambers weekly from May to September 2015 and peat samples were incubated in laboratory to measure CH4 production and consumption potentials. Methane fluxes at the site were generally low, but after 16 years, mean CH4 emissions have increased and more than doubled in high nitrogen addition treatments if P and K input was also increased (3.2 and 6.4 g N m-2yr-1 with PK), owing to drastic changes in vegetation and soil moisture. Vegetation changes include a loss of Sphagnum moss and introduction of new species, typical to minerogenic mires, which together with increased decomposition have led to decreased surface elevation and to higher water table level relative to the surface. The trajectories indicate that the N only treatments may result in similar responses, but only over longer time scales. Elevated atmospheric deposition of nutrients to peatlands may increase loss of C not only due to changes in CO_2 exchange but also due to enhanced CH4 emissions in peatlands through a complex suite of feedbacks and interactions among vegetation, microclimate, and microbial processes. It is uncertain, however, how the vegetation change continues due to collapsing surface and higher water table levels, and how that will affect future CH4 emissions and C balance.