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Does high reactive nitrogen input from the atmosphere decrease the carbon sink strength of a peatland?

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Mid-latitude peatlands are often exposed to high atmospheric nitrogen deposition when located in close vicinity to agricultural land. As the impacts of altered deposition rates on nitrogen-limited ecosystems are poorly understood, we investigated the surface-atmosphere exchange of several nitrogen and carbon compounds using multiple high-resolution measurement techniques and modeling. Our study site was a protected semi-natural bog ecosystem. Local wind regime and land use in the adjacent area clearly regulated whether total reactive nitrogen (ΣN_r) concentrations were ammonia (NH_3) or NO_x-dominated. Eddy-covariance measurements of NH_3 and ΣN_r revealed concentration, temperature and surface wetness-dependent deposition rates. Intermittent periods of NH_3 and ΣN_r emission likely attributed to surface water re-emission and soil efflux, respectively, were found, thereby indicating nitrogen oversaturation in this originally N-limited ecosystem. Annual dry plus wet deposition resulted in 20 to 25 kg N ha^{-1} depending on method and model used, which translated into a four- to fivefold exceedance of the ecosystem-specific critical load. As the bog site had likely been exposed to the observed atmospheric nitrogen burden over several decades, a shift in grass species' composition towards a higher number of nitrophilous plants was already visible. Three years of CO_2 eddy flux measurements showed that the site was a small net sink in the range of 33 to 268 g CO_2 m^{-2} yr^{-1}. Methane emissions of 32 g CO_2-eq were found to partly offset the sequestered carbon through CO_2. Our study indicates that the sink strength of the peatland has likely been decreased through elevated N deposition over the past decades. It also demonstrates the applicability of novel micrometeorological measurement techniques in biogeochemical sciences and stresses the importance of monitoring long-term changes in vulnerable ecosystems under anthropogenic pressure and climate change.