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Atmospheric N deposition and feedbacks on net ecosystem CO_2 exchange at a semi-natural peatland site

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Large areas of Northern Germany have been converted from natural peat bogs to arable land and were subjected to draining and peat cutting in the past. The few protected peatland areas remaining are affected by high nitrogen (N) deposition. This is the case at our study site – a semi-natural raised bog – which although located in a natural park, is surrounded by highly fertilized agricultural land and highly emitting animal husbandry farms. In this study, we use a combined approach of two independent methods to quantify atmospheric N deposition. We further investigate possible feedbacks of seasonal variation in N deposition on net ecosystem CO_2 exchange (NEE). Fluxes of ammonia (NH3) and its atmospheric reactants are measured by a KAPS-denuder system. Additionally, total N input from the atmosphere into a soil-plant model ecosystem is investigated by a 15N dilution method called 'Integrated Total Nitrogen Input' (ITNI). With this approach, we allocate atmospheric N after its uptake by the ecosystem into its different fractions and investigate both plant-species effects (Lolium multiflorum, Eriophorum vaginatum) and influences of the plant biomass production induced by different amounts of fertilizer addition. Continuous eddy-covariance measurements are carried out to measure NEE.
Maximum NH3 depositions of 0.41 $\pm$ 0.04 kg ha-1 week-1 were found in spring 2012. The proportion of fluxes of other N compounds such as HNO_3, aerosol NH4 and NO_3 was usually around 20 % of total dry N measured by KAPS denuders. In total, dry N deposition was 11.2 $\pm$ 0.9 kg N ha-1 yr-1 over the first year of experiments. Complemented with wet N measurements using bulk samplers, total N depositions of about 25.0 kg ha-1 yr-1 were found. The mean atmospheric N uptake determined with the ITNI system was 3.99 $\pm$ 0.82 mg N g-1 dry weight from July to October 2011. About two third of total deposited airborne N was allocated in above-ground plant biomass and roots. Upscaling of data based on pot area resulted in a total N input of 24.06 $\pm$ 3.55 kg N ha-1 yr-1 into the ITNI system. Cumulative NEE was about -241 g C m-2 yr-1 for the first year of experiments with the strongest CO_2 uptake being observed during spring and early summer. During winter, photosynthesis slightly exceeded respiration.
Our results show that the critical load of N deposition for peatlands ($\sim$5 kg N ha-1 yr-1) is fivefold exceeded. Most likely, the intensive agricultural land management of the surrounding areas leads to this high N deposition into the protected peatland area. Future changes in plant species composition and the local hydrological regime cannot be excluded. A link between N input and comparatively high CO_2 uptake will be discussed.