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Bark vegetation contributes to nitrous oxide (N2O) deposition by mature beech trees

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Nitrous oxide (N_2O) contributes to the acceleration of the greenhouse effect. Accordingly, there is an urgent need to investigate the natural capability of forest ecosystems to exchange N_2O with the atmosphere. While the soils of temperate forests were shown to be a significant natural source of N_2O, trees have been so far overlooked in the forest N_2O inventories. Trees are known, however, to emit this gas, especially at very high N_2O concentration in soil.

We determined the N_2O fluxes in mature beech trees (*Fagus sylvatica*) in two upland mountain forests (White Carpathians, CZ; Black Forest, DE) with predominant soil N_2O uptake. To understand these fluxes, N_2O exchange in photoautotrophic organisms associated with beech stems (lichens, mosses, and algae) was further investigated under laboratory conditions. Fluxes were measured in situ in June and July 2015 using static chamber systems followed by chromatographic and photo-acoustic analyses of N_2O concentration changes.

In both forests studied, all beech stems deposited N_2O from the atmosphere. Such consistent uptake of N_2O by stems represents a novel and unique finding which is in the contrast to current limited studies presenting trees as N_2O emitters. The mean stem deposition rates were significantly higher in the White Carpathians (-3.8 μg N_2O m^{-2} stem area h^{-1}) than in the Black Forest (-2.3 μg N_2O m^{-2} h^{-1}). The forest floor was a strong sink for N_2O (White Carpathians: -111, Black Forest: -81 μg N_2O m^{-2} soil area h^{-1}). The N_2O concentration profiles within the soil did not identify any apparent production or consumption processes.

Photoautotrophic organisms (lichens, mosses, and algae), largely associated with the bark of studied trees, were collected for further analyses. The detailed incubation experiments revealed that all sampled organisms deposited N_2O under the conditions of full rehydration and air temperature of 25°C. Their deposition rates per unit area were in the same order of magnitude as compared to stem deposition rates measured under the field conditions. Specifically, it was -1.3, -2.0, and -1.8 μg N_2O m^{-2} h^{-1} for algae, lichens, and mosses, respectively.

Therefore, it seems that bark vegetation is at least co-responsible for the observed unique deposition of N_2O by beech trees.

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