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Nitrogen cycling in ombrotrophic peat bogs in the Czech Republic: Is microbial N-fixation occurring at atmospheric depositions of reactive N higher than 10 kg/ha/yr?

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Biogeochemical cycling of carbon (C) and nitrogen (N) in peat bogs are coupled. Whereas at low pollution levels, reactive nitrogen (Nr, mainly nitrate- and ammonium-N) inputs may positively affect C storage, high Nr deposition may have a detrimental effect on C storage.
We have previously reported N isotope systematics at two ombrotrophic peat bogs in the Czech Republic, receiving medium levels of Nr of about 10 kg/ha/yr via atmospheric deposition. Nitrogen of living Sphagnum was systematically heavier than N of the atmospheric input ($p < 0.001$), and close to the N isotope signature of atmospheric N2 (del15N-N2 of 0.0 per mil). We argued that even at medium Nr pollution, such as that in the Czech Republic, the amount of Nr in rainfall becomes minute toward the end of major precipitation events, possible triggering off microbial N-fixation. This process may be responsible for the del15N shift in Sphagnum from negative values of atmospheric deposition to the zero value of N2. In 2016, we conducted a laboratory study in which living Sphagnum from sites receiving annually slightly over 10 kg Nr/ha/yr via atmospheric deposition was incubated in an atmosphere enriched in 15N-N2. At the end of the incubation, we detected a 1 to 3 per mil increase in del15N of Sphagnum. Rinsing Sphagnum capitula in deionized water prior to the 15N-N2 incubation has led to a slight further increase in del15N of Sphagnum. Also in 2016, we monitored del15N of atmospheric deposition at three medium Nr-polluted peat bogs. Open-area precipitation had the following mean del 15N values: Uhlirska -6.1 per mil (NH4) and -6.2 per mil (NO_3); Brumiste -1.7 per mil (NH4) and -3.4 per mil (NO_3); Male Mechove Jezirko -3.3 per mil (NH4) and -3.9 per mil (NO_3). At all sites, atmospheric Nr deposition was made up by NO_3-N and NH4-N in a roughly 1.1 ratio. We found that N of winter-time deposition became isotopically extremely light (less than -10.0 per mil). During the growing season, del15N of total atmospheric input was higher, closer to 0.0 per mil, but still slightly lower than del15N of living Sphagnum. These data thus confirm a N isotope discrepancy between the N isotope signature of deposition and Sphagnum. In the paper, we will also discuss a mass balance discrepancy in long-term atmospheric N input and N storage at the Czech sites, determined for replicated, lead-210 dated peat cores. We took into consideration a 30 % contribution of horizontal deposition (mainly fog interception), which we had directly measured, to total Nr deposition. Still, the dated peat cores appeared to accumulate 30 to 60 % more N than the maximum estimated atmospheric Nr input (both estimates for the period 1900-2015). Preliminarily, we conclude that three independent lines of evidence indicate intermittent N-fixation even at medium Nr-polluted peat bogs in Central Europe.