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Canopy interception of nitrogen deposition in mountain forests: results from an above-canopy fertilization with labelled N

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In the last few decades, the emission of reactive nitrogen (Nr) in the atmosphere through human activities has strongly raised, causing an increase in nitrogen (N) deposition, which has several potential effects on terrestrial ecosystems, including forests. The growth of temperate and boreal forests is considered to be limited by N and therefore the increasing availability of Nr may lead to an increase in forest productivity and C uptake, with a positive feedback on climate change mitigation potential of forest ecosystems. On the other hand, forest fertilisation experiments have evidenced several negative consequences of increased N availability such as soil acidification, nutrient deficit, loss of biodiversity, increment in greenhouse gases emissions and an increase tree mortality. Most of these studies have simulated N deposition by applying N fertilisation directly to the soil. This approach neglects the role of the canopy, which has been proved to influence the nitrogen use efficiency, other than the quantity and the chemical form of the N deposition reaching the soil.

For this reason, in 2014 a field-scale manipulation experiment was established in a temperate sub-mountain forest in Bolzano province, with the overall aim to evaluate the effects of nitrogen deposition on temperate forests by applying aerial N fertilization over the tree canopy (N_{AB}) and comparing it to the fertilization applied to the ground (N_{BL}). The fertilizations are applied monthly from May to September and the total N added corresponds to 20 kg N ha^{-1} yr^{-1}.

To study the fate of the added N in both the fertilisation approaches, in July 2016 a fertilisation treatment was performed using isotopic labelled fertiliser ($^{15}NH_4^{15}NO_3$). Labelled N was tracked throughout the ecosystem by analysing its presence in the different ecosystem compartments (plants and soil). For this reason, samples of plant biomass (fresh leaves, leaf litter and wood) and soil were sampled first in July 2016, 20 days after the fertilization, and successively at the beginning of March 2017, eight months after the fertilisation. The samples were analysed for the ^{15}N isotopic signature ($\delta^{15}N$) with a continuous-flow isotopic ratio mass spectrometer coupled with an elemental analyser and the recovery of the added N was determined with an isotopic mass balance.

In both fertilization approaches, most of the labelled N was recovered in the soil compartment. However, the recovering of fertilised-labelled N in plant tissues was much more in N_{AB} than in N_{BL} treatment. This finding points out the importance of considering tree canopy in experiments simulating the effect of N depositions on forest ecosystems. However, considering the chronic nature of the N deposition process and the slowness by which forest ecosystems can react to this type of perturbations, only manipulative long-term experiments can improve our understanding of the effect of N deposition on forest ecosystems.