Spruce stems and resins constitute a strong sink for methane (CH$_4$)

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Introduction

Woody plants are known to emit methane (CH$_4$) as an important greenhouse gas into the atmosphere. Recent studies show that tree stems might be also sinks for CH$_4$; however, the mechanisms of CH$_4$ uptake and its fate are unknown. Norway spruce (Picea abies) is characterised as negligible CH$_4$ source in boreal forests. Even though spruce trees have been widely planted for its wood in large-scale monocultures in European temperate forests, no studies have focused on their CH$_4$ exchange potential in the temperate zone.

Experimental design

The measurements were performed at the experimental station Kranzberger Forst near Freising, Southern Bavaria, Germany, in June 2019. Fluxes of CH$_4$ were measured i) in mature tree stems using non-steady-state stem chamber systems (n=32) installed in stem vertical profiles, ii) in naturally exuded resins sampled from studied stems (n=5) using incubation chambers, and iii) in soil at three position (n=3) using non-steady state soil chambers. Fluxes were detected using a portable greenhouse gas analyser.

Results

Result 1: Spruce stems can be a strong sink for CH$_4$, even if a small amount of resin is present on the bark. In contrast, stem surfaces without visible presence of resins consume CH$_4$ at negligible rates.

Result 2: Stem CH$_4$ uptake potential increases with increasing stem surface area covered with resin residuals.

Result 3: Resins consistently consume CH$_4$. After re-calculation of stem fluxes to resin area, the CH$_4$ uptake rates of stems and resins were in the same order of magnitude (-13.2 and -12.0 mg CH$_4$ m$^{-2}$ resin area h$^{-1}$, resp.). The exuded resins are at least co-responsible for the strong CH$_4$ uptake by spruce stems.

Result 4: The CH$_4$ uptake by predominant spruce stems with resin exudation contributes by 97.1% to the soil CH$_4$ uptake and can even equally contribute to the forest CH$_4$ exchange. Tree stems without visible resin residuals contributes by only 2.4% to the soil CH$_4$ uptake.

Conclusion: the spruce resins appear to be strong and until now undiscovered CH$_4$ sink. Even one small droplet of resins on bark can turn the negligible CH$_4$ exchange of intact spruce stems into strong CH$_4$ sinks, having thus severe impact on the overall forest CH$_4$ balance. This uptake potential of resins should be considered by estimation of forest CH$_4$ balance especially in areas, where resin bleeding is widely spread or is to be expected (bark-beetle areas, tree harvest, clear-cutting).

Acknowledgements

This research was supported by Czech Science Foundation (17-18112Y) and National Sustainability Program I (LO1415). We thank Thorsten Grams, Jan Hrdlička and Thomas Feuerbach for their support.

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