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.

Research activities and aims

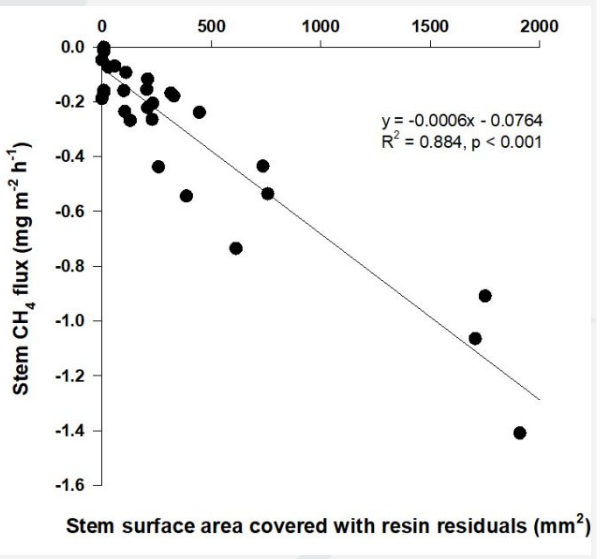
We determined CH_4 exchange of Norway spruce stems, of resins exuded by these stems (covering 4.8 ± 1.3% of stem area in chambers), and of adjacent soil in a temperate upland forest. We aimed to find out whether and to which extent the spruce stems and resins exchange CH_4 with the atmosphere and how they contribute to the forest CH_4 exchange.

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.

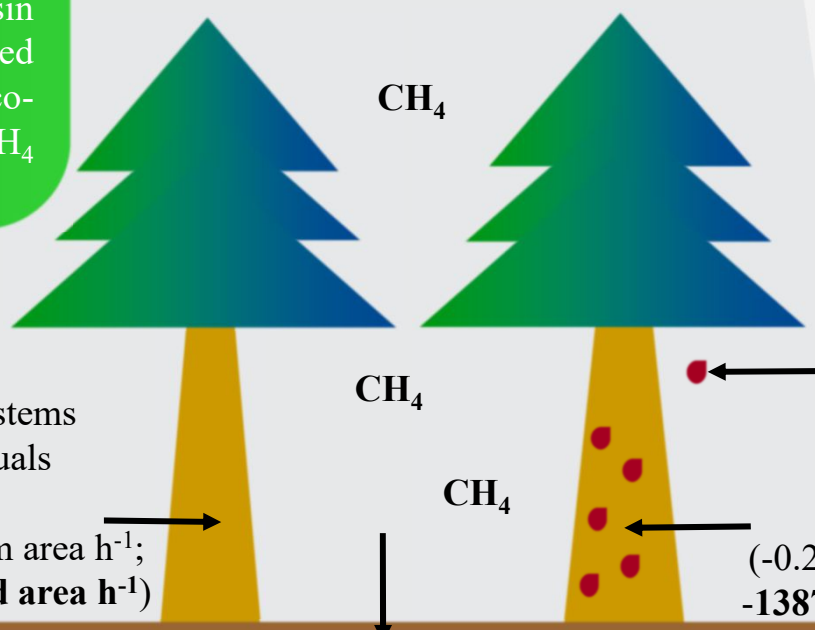
Result 1: Spruce stems can be a strong sink for CH_4, even if a small amount of resin is present on the bark. In contrast, stem surfaces without visible presence of resins consume CH_4 at negligible rates.

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.



Strong CH_4 uptake by resin residuals
(-12.0 ± 1.7 mg CH_4 m^{-2} resin area h^{-1})

Negligible CH_4 uptake by stems without visible resin residuals (in minority)
(-0.007 ± 0.001 mg CH_4 m^{-2} stem area h^{-1};
-33.7 ± 6.5 mg CH_4 ha^{-1} ground area h^{-1})

Strong CH_4 uptake by stems with resin residuals
(-0.288 ± 0.053 mg CH_4 m^{-2} stem area h^{-1};
-1387 ± 257 mg CH_4 ha^{-1} ground area h^{-1})

Strong CH_4 uptake by soil
(-0.150 ± 0.018 mg CH_4 m^{-2} soil area h^{-1};
-1495 ± 175 mg CH_4 ha^{-1} ground area h^{-1})

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).

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