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Seasonal courses revealed that boreal trees emit methane even during winter time

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Boreal forests are considered to be a significant natural sink of methane (CH_4) due to predominant soil deposition of CH_4 from the atmosphere. However, plants are known to contribute to the CH_4 exchange with the atmosphere. Fluxes of CH_4 have been mostly studied on herbaceous plants, whereas investigations on trees, particularly boreal tree species, are sporadic.

Therefore we determined CH_4 fluxes from common boreal tree species: Scots pine (*Pinus sylvestris*), Norway spruce (*Picea abies*) and silver birch (*Betula pendula*). The objectives were to investigate whether these tree species contribute to CH_4 exchange with the atmosphere, particularly in winter, how soil water content affects these fluxes, and how trees contribute to overall forest CH_4 fluxes.

The measurements were performed on mature trees in the boreal forest surrounding the SMEAR II station in Finland. Fluxes of CH_4 at stem and forest floor level were simultaneously measured over the whole year (from June 2014 until May 2015) using static chamber systems and quantified by gas chromatographic analyses.

Our results show that the trees mostly emitted CH_4 in the summer. Birch was the strongest emitter of CH_4(9.5 μg CH_4 m^{-2}stem area h^{-1}, medians) among the tree species studied, particularly under high soil volumetric water content (0.92 $\pm$ 0.01 m^3 m^{-3}). Similarly, the forest floor released CH_4 into the atmosphere (37 μg CH_4 m^{-2} soil area h^{-1}). Under low soil water content (0.37 $\pm$ 0.02 m^3 m^{-3}), the flux rates from stems of birch and pine decreased but remained mostly positive (i.e. emissions), whereas forest floor reversed to sink for CH_4 (-44 μg CH_4 m^{-2} h^{-1}). In contrast, spruce CH_4 emissions increased with decreasing soil water content up to 0.55 μg CH_4 m^{-2} h^{-1}. In general, the emission rates of all the tree species decreased from September/October onwards. In the winter, the tree fluxes remained low, but slightly positive, and increased again in the spring. The CH_4 fluxes were modulated by soil water content also during the winter period.

Summarised, boreal tree species and their CH_4 emissions play an important role in the ecosystem CH_4 exchange, thus reducing the sink strength of boreal forest soils. Therefore, it is necessary to incorporate tree CH_4 fluxes and their seasonal variations in the estimation of CH_4 balance of boreal forests.

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