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Methane (CH_4) fluxes in trees of temperate and boreal zones. What have we learned?

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The increase in atmospheric methane (CH_4) concentration affects global radiative forcing consequently leading to changes in the Earth's climate. Plants are known to be able to emit CH_4 under certain conditions; however, the role of trees, especially upland tree species, in the CH_4 exchange of forest ecosystems is still not well understood. We have particularly investigated (1) whether trees exchange CH_4 with the atmosphere, (2) to which extent trees contribute to net ecosystem CH_4exchange, (3) how soil water content affects the tree fluxes and (4) whether these fluxes show seasonal dynamics.

To answer these questions, we have measured, since 2009, stem CH_4 fluxes in a wide spectrum of tree species under different environmental conditions in the Czech Republic, Germany, and Finland, including seasonality of these fluxes. The fluxes were studied in common broad-leaf and coniferous tree species of boreal and temperate zones: Scots pine (*Pinus sylvestris*, including shoot fluxes), Norway spruce (*Picea abies*), European beech (*Fagus sylvatica*), bay and crack willow (*Salix pentandra*, *S. fragilis*), black alder (*Alnus glutinosa*), downy and silver birch (*Betula pubescens*, *B. pendula*), and poplar hybrids (*Populus* sp.). Stem and also forest floor fluxes were measured using static chamber systems followed by gas chromatographic and/or laser analyses of CH_4 concentration changes. Such a broad data set enables now to make some general conclusions about the role of trees in the forest ecosystem CH_4 exchange.

Our research revealed that stems of all tree species studied mostly emitted CH_4 into the atmosphere, even though the studied soils, except wetlands, were predominant sinks for CH_4. The CH_4 emissions decreased with increasing stem height and being highest close to the soil surface. The stem CH_4 emissions showed high spatial heterogeneity likely related to variability in soil water content (larger scale) and variability in subsoil CH_4 production (small scale). Different seasonal courses in CH_4 and CO_2 emissions were observed. While high CH_4 emissions were detected in stems of pine, spruce, birch, and willow trees during the winter and/or spring time; CO_2 respiratory efflux, an indicator of a physiological activity, was substantialy reduced. Since shoot CH_4 emissions in pine trees were substantially higher than emissions from stems, shoots might be the primary tree surface emitting CH_4 into the atmosphere. Therefore, the up to now rarely investigated shoot fluxes have to be incorporated in the future experiments.

All tree species studied contributed to the CH_4 exchange between forest ecosystems and the atmosphere, indicating that these fluxes need to be included in the forest CH_4 emission inventories.

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