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The effect of forest management on trace gas exchange at the pedosphere-atmosphere interface in beech forests stocking on calcareous soils

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The effect of forest management (thinning) on in situ carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) trace gas exchange between soil and the atmosphere was studied in three consecutive years at three beech forest sites, which differ in aspect (southwest, northeast, northwest). At all sites adjacent thinning plots ("T") and untreated control plots ("C") were established. Measurements at the southwest (SW) and northeast (NE) site covered the years four to six after thinning while at the northwest (NW) site measurements covered the year before and the first two years after thinning. Mean N_2O fluxes were <3 μg N_2O-N m^{-2} h^{-1} at all plots except for the newly thinned NWT plot. Very low CH_4 oxidation rates during dry periods are explained by physiological drought stress for CH_4 oxidizers. Heterotrophic litter respiration constitutes the largest part of total soil respiration. On the whole, no significant positive or negative effects of the silvicultural treatment on the magnitude of CO_2, CH_4 and N_2O trace gas exchange could be observed at the SW site four to six years after thinning. Also at the NE site, no effects of thinning on CO_2 and N_2O fluxes could be demonstrated. However, at this site a significant moisture-induced lower CH_4 uptake could be shown. At the NW site forest management lead to a dramatic increase in N_2O emissions in the first two summers after thinning and to distinct effects on CO_2 emissions and CH_4 uptake in the first year after the felling. The unambiguous effects of thinning at the NW site are mainly related to enhanced mineralization activity, to a shift in the competition for nutrients favouring microorganisms as compared to trees

and to changes in the soil water availability at the thinned plot. Considering the data obtained from the NE and SW site we expect that with the development of an understorey vegetation at the NW site the observed effects on the magnitude of trace gas exchange due to thinning will continue to decline in the following years. Our results implicate that it is indispensable to take account of the effects of forest management in order to accurately calculate trace gas emission inventories for forest soils.