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1 Effects of Soil Frost on Fluxes and Radiocarbon Signature of Soil Respiration in a Norway Spruce Forest soil

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Climate models predict a regional increase of the frequency and intensity of soil frost with possibly strong effects on C cycling of soils. In this study, we induced mild soil frost (-5˚C in a depth of 5 cm below surface) in a Norway spruce forest soil by removing the natural snow cover in the winter of 2005/2006. Soil frost lasted from January 2006 to April 2006 and was detected down to a depth of 15 cm. Soil frost effectively reduced soil respiration in the snow removal plots in comparison to undisturbed control plots. On an annual basis 6.2 t C ha^{-1} a^{-1} were emitted in the control plots compared to 5.1 t C ha^{-1} a^{-1} in the snow removal plots. Only 14 % of this difference were attributed to reduced soil respiration during the soil frost period itself, whereas 63 % of this difference originated from differences during the summer of 2006. Radiocarbon ($\Delta^{14}C$) signature of CO_2 revealed a considerable reduction of heterotrophic respiration on the snow removal plots. Similar CO_2 concentrations in the uppermost mineral horizons of both treatments indicate that differences between the treatments originated from the organic horizon. Extremely low water contents between June and October of 2006 may have inhibited the recovery of the heterotrophic organisms from the frost period, thereby enhancing the differences between the control and snow removal plots. We conclude that soil frost triggered a change in the composition of the microbial community, leading to an increased sensibility of heterotrophic respiration

to summer drought. A CO_2 pulse during thawing, like described for arable soils several times throughout the literature, with the potential to partly compensate for reduced soil respiration during soil frost, was completely lacking for this soil. Our results from this experiment indicate that soil frost reduces C emission from forest soils, whereas mild winter may enhance C losses from forest soils.