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Age of respired carbon in differently managed grassland and forest soils

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Grassland management (fertilization, grazing, mowing) and forest management (harvesting, thinning) directly affect biomass production and related leaf and root litter input to the soil. Understanding effects of land management on soil carbon fluxes is therefore critical. We examined the effect of land use and management on soil respiration and the age of respired soil carbon. Soil samples originated from grassland and forest plots in three different German regions. Sieved surface soil samples (0-10 cm) were incubated (20°C, 60% WHC) for 14 days. The respired CO_2 was collected and 14C contents in the CO_2 of 150 incubated samples were determined with accelerator mass spectrometry (AMS). Large changes recorded in 14C in the atmosphere since atmospheric weapons testing in the 1960s allow precise determination of the mean age of emitted soil carbon.

In our study, the rate of respiration was higher in grassland soils (33 $\pm$ 10 μg C-CO_2 per g dry soil per day) compared to forest soils (14 $\pm$ 7 μg C-CO_2 per g dry soil per day). Results indicate a strong relation between respiration rates and grassland management with lower soil respiration in more fertilized plots. This relation was not found at sites where degraded peatlands were used as grasslands. At those sites, respiration rates were mainly driven by the soil organic carbon concentration. In forest soils, we did not find any relation between soil respiration and forest management.

The 14C contents of the respired CO_2 were lower in grassland soils (Percentage Modern carbon content: 104$\pm$2%) compared to forest soils (Percentage Modern Carbon content: 108$\pm$5%). This indicates that the carbon respired in forests is generally several years to more than a decade older than the carbon respired in grasslands. In grasslands, the 14C is positively related to the respiration rate and negatively related to fertilization. Again, degraded peat soils, where old carbon is released during incubation, were the exception to this pattern. In forests, older carbon is emitted from soils with a low pH value indicating a possible tree species effect. Preliminary results also suggest a link between the age of respired CO_2 and the 14C root age. Overall, this study shows that the age of respired carbon, which reflects the age of soil carbon pools that are decomposing fastest, is sensitive to land use and management. The results demonstrate that the age of respired carbon is not only giving us information about decomposition rates but also reflects time lags in the vegetation.