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Change in autotrophic and heterotrophic soil CO_2 efflux following rainfall exclusion in a spruce forest

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Many soils will be subjected to increasing drying/wetting cycles or modified water availability considering predicted global changes in precipitation and evapotranspiration in the next decades. These changes may affect the turnover and storage of C in soils, but the direction of changes is still unclear. Here we present results of a summer throughfall exclusion experiment that was performed in a Norway spruce forest during two consecutive years in the Fichtelgebirge, Germany. Total cumulative CO_2 efflux was reduced by 14% (100 g C m^{-2} yr^{-1}) in the throughfall exclusion plots. Partitioning of the CO_2 efflux using the radiocarbon signature of respired CO_2 from roots, soil organic matter and the total soil revealed a strong contribution of heterotrophic respiration to the total CO_2 efflux. Root respiration, including the CO_2 release by mycorrhiza and other heterotrophic organisms within the rhizosphere, was less affected by the simulated summer drought than the C mineralization of soil organic matter. Soil CO_2 profile concentrations indicate a strong decrease of CO_2 production in the organic horizons while the mineral soil was barely affected by throughfall exclusion. Our results suggest that roots of Norway spruce partly compensated the water shortage possibly by redistribution of water from deeper soil horizons. Wetting of soil had a minor effect on soil CO_2 efflux, indicating in contrast to many other studies no wetting pulse due to mineralisation of labile organic compounds. Extended dry summer seasons may reduce C losses of the standing soil organic stock, however, the future development of soil C stocks also will be affected by litter input.