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Admixing fir to European beech forests to increase resilience in a changing climate: Effects on soil organic carbon stocks and soil-atmosphere exchange of greenhouse gases

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Increasing frequency and intensity of summer droughts as well as heavy precipitation events are observed in Central Europe and are expected to gain further importance in a changing climate. Because this is posing severe challenges for the sustainability of the drought-sensitive European beech forests, admixing deep-rooting silver fir has been proposed as a measure to increase the resilience of beech forests in a changing climate. However, the consequences of admixing fir to beech forests on soil organic carbon (SOC) and total nitrogen (TN) stocks and changes in the soil-atmosphere exchange of greenhouse gases (GHG) are not well understood. In this study we examined the effect of fir admixture to beech forests on SOC and TN stocks as well as soil-atmosphere-exchange of GHGes (CO_2, CH_4 and N_2O) in two forest stands in the Black Forest, Southern Germany and in the Velebit mountains, Croatia. To gain insight into the impact of drying-wetting events, we simulated prolonged summer drought periods by installation of roofs of two-and-a-half (2016) and three months (2017), respectively. Furthermore, a rainfall event was simulated at the end of both drought periods. Data so far available suggest that admixing of fir – besides small changes in the forest floor – did not significantly affect SOC and TN stocks. Admixture of fir to pure beech stands reduced soil respiration, especially during autumn and winter, which appeared to be related to changes in litter quality. Overall, no significant effect of the admixture on CH_4 and N_2O fluxes was found, though there was a tendency of higher CH_4 - uptake under simulated drought. Generally, N_2O fluxes were low and are not relevant for the GHG balance. The results are relevant for predicting GHG emissions under different sivicultural practices as well as estimating the carbon balance of forest soils under the auspices of climate change.