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Effects of climate change on soil organic matter chemical composition and carbon content in different physical fractions

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Soil organic matter (SOM) is composed of many pools with different properties (e.g. turnover times) which are generally used in biogeochemical models to predict carbon (C) dynamics. Physical fractionation methods are applied to isolate soil fractions that correspond to these pools. This allows the characterisation of chemical composition and C content of these fractions. There is still a lack of knowledge on how these individual fractions are affected by different climate change drivers, and therefore the fate of SOM remains elusive. We sampled soils from a multifactorial climate change experiment in a managed grassland in Austria four years after starting the experiment to investigate the response of SOM in physical soil fractions to temperature (eT: ambient and elevated by +3°C), atmospheric CO_2-concentration (eCO_2: ambient and elevated by +300 ppm) and to a future climate treatment (eT x eCO_2: +3°C and + 300 ppm). A combination of slaking and wet sieving was used to obtain three size classes: macro-aggregates (maA, > 250 µm), micro-aggregates (miA, 63 µm – 250 µm) and free silt & clay (sc, < 63 µm). In both maA and miA, four different physical OM fractions were then isolated by density fractionation (using sodium polytungstate of ρ = 1.6 g*cm^{-3}, ultrasonication and sieving): Free POM (fPOM), intra-aggregate POM (iPOM), silt & clay associated OM (SCaOM) and sand-associated OM (SaOM). We measured C and N contents and isotopic composition by EA-IRMS in all fractions and size classes and used a Pyrolysis-GC/MS approach to assess their chemical composition. For eCO_2 and eT x eCO_2 plots, an isotope mixing-model was used to calculate the proportion of recent C derived from the elevated CO_2 treatment. Total soil C and N did not significantly change with treatments. eCO_2 decreased the relative proportion of maA-mineral-associated C and increased C in fPOM and iPOM. About 20% of bulk soil C was represented by the recent C derived from the CO_2 fumigation treatment. This significantly differed between size classes and density fractions ($p < 0.001$), which indicates inherent differences in OM age and turnover. Warming reduced the amount of new C incorporated into size classes. We found that each size class and fraction possessed a unique chemical fingerprint, but this was not significantly changed by the treatments. Overall, our results show that while climate change effects on total soil C were not significant after 4 years, soil fractions showed specific effects. Chemical composition differed significantly between size classes and fractions but was unaffected by simulated climate change. This highlights the importance to separate SOM into differing pools, while including changes to the molecular composition might not be necessary for improving model predictions.