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Stimulation of microbial extracellular enzyme activities by elevated CO2 depends on soil aggregate size

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Increased belowground carbon (C) transfer by plant roots at elevated CO2 may change properties of the microbial community in the rhizosphere. Previous investigations that focused on total soil organic C or total microbial C showed contrasting results: small increase, small decrease or no changes. We evaluated the effect of 5 years of elevated CO2(550 ppm) on four extracellular enzymes: ß-glucosidase, chitinase, phosphatase, and sulfatase. We expected microorganisms to be differently localized in aggregates of various sizes and, therefore analyzed microbial biomass (Cmic by SIR) and enzyme activities in three aggregate-size classes: large macro- (>2 mm), small macro- (0.25–2 mm), and microaggregates (<0.25 mm). To estimate the potential enzyme production, we activated microorganisms by substrate (glucose and nutrients) amendment. Although Ctotal and Cmic as well as the activities of ß-glucosidase, phosphatase, and sulfatase were unaffected in bulk soil and in aggregate-size classes by elevated CO2, significant changes were observed in potential enzyme production after substrate amendment. After adding glucose, enzyme activities under elevated CO2 were 1.2–1.9-fold higher than under ambient CO2. This indicates the increased activity of microorganisms, which leads to accelerated C turnover in soil under elevated CO2. Significantly higher chitinase activity in bulk soil and in large macroaggregates under elevated CO2 revealed an increased contribution of fungi to turnover processes. At the same time, less chitinase activity in microaggregates underlined microaggregate stability and the difficulties for fungal hyphae penetrating them. We conclude that quantitative and qualitative changes of C input by plants into the soil at elevated CO2 affect microbial community functioning, but not its total content. Future studies should therefore focus more on the changes of functions and activities, but less on the pools.