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Sensitivity of soil organic matter in anthropogenically disturbed organic soils

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Drained peatlands are hotspots of carbon dioxide (CO_2) emissions from agriculture. However, the variability of CO_2 emissions increases with disturbance, and little is known on the soil properties causing differences between seemingly similar sites. Furthermore the driving factors for carbon cycling are well studied for both genuine peat and mineral soil, but there is a lack of information concerning soils at the boundary between organic and mineral soils. Examples for such soils are both soils naturally relatively high in soil organic matter (SOM) such as Humic Gleysols and former peat soils with a relative low SOM content due to intensive mineralization or mixing with underlying or applied mineral soil. The study aims to identify drivers for the sensitivity of soil organic matter and therefore for respiration rates of anthropogenically disturbed organic soils, especially those near the boundary to mineral soils. Furthermore, we would like to answer the question whether there are any critical thresholds of soil organic carbon (SOC) concentrations beyond which the carbon-specific respiration rates change.

The German agricultural soil inventory samples all agricultural soils in Germany in an 8x8 km^2 grid following standardized protocols. From this data and sample base, we selected 120 different soil samples from more than 80 sites. As reference sites, three anthropogenically undisturbed peatlands were sampled as well. We chose samples from the soil inventory a) 72 g kg-1 SOC and b) representing the whole range of basic soil properties: SOC (72 to 568 g kg-1), total nitrogen (2 to 29 g kg-1), C-N-ratio (10 to 80) bulk density (0.06 to 1.41 g/cm^3), pH (2.5 to 7.4), sand (0 to 95 %) and clay (2 to 70 %) content (only determined for samples with less than 190 g kg-1 SOC) as well as the botanical origin of the peat (if determinable). Additionally, iron oxides were determined for all samples. All samples were sieved (2 mm) and incubated at standardized water content and in three replicates using an automated incubation ("Heinemeyer") device. CO_2 production is measured for basal respiration and substrate induced respiration (SIR) with glucose addition. To determine the equilibrium values of the basal respiration impartially, an exponential model is fitted to the measured data using the Differential Evolution Adaptive Metropolis (DREAM) algorithm. Applying this approach, we can consider all three replicates simultaneously and quantify uncertainties of the basal respiration rate.