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Multistep outflow experiments for the simultaneous determination of soil physical and CO2 production parameters

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The response of soil carbon decomposition to climate change is of great importance because terrestrial soils act as the largest carbon sink worldwide. This large carbon pool interacts strongly with the atmosphere and vegetation, and even small relative changes in organic storage in the soil could constitute a significant feedback effect on greenhouse gases in the atmosphere. CO2 modelling approaches seem to be a powerful tool to describe the influence of changes in soil temperature and soil water content on carbon decomposition. However, comprehensive datasets with a complete description of water movement and CO2 production are rare in literature. Therefore, multistep outflow experiments were conducted on large soil columns to simultaneously determine soil physical and CO2 production parameters necessary for mechanistic carbon decomposition modelling. The experimental set-up consists of a soil column of 0.30 by 0.20 m placed on a suction plate, which can be used to apply a prescribed pressure to the bottom of the soil column and to collect the out flowing water. The soil column is equipped with 4 tensiometers, 3 TDR sensors, 3 sensors that measure the CO2 concentration in the soil air phase using infrared gas analyzer technology, and 3 oxygen concentration sensors. CO2 respiration was measured with a LICOR flux chamber placed on top of the soil column. This comprehensive dataset was first used to inversely estimate the hydraulic parameters using the SOILCO2 model, which is a mechanistic description of water, heat, and CO2 transport. In a second step, these hydraulic parameters were used to inversely estimate the initial C-pool sizes and carbon turnover rates as a function of soil water content using a coupled version of SOILCO2 and the biological C turnover model RothC.