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Modeling of soil carbon turnover under different crop management: Calibration of RothC-model for Pannonian climate conditions

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Despite our knowledge about soil C dynamics, very few long-term data concerning soil organic C dynamics are available for calibrating and evaluating C models. The long-term 14C turnover field experiment, established in 1967 in Fuchsenbigl, Lower Austria, offers the unique opportunity to investigate the mineralization and stabilization of 14C-labeled wheat straw and farmyard manure under different cropping systems (crop rotation CR, spring wheat SW and bare fallow BF) in a long-term field experiment established by H.-E. Oberländer in 1967 in Fuchsenbigl/Lower Austria.

In this work the Roth-C-26.3-model was calibrated for the Pannonian climatic region based on the field experiment results. Decomposition rate constants were modified regarding the possible climatic influence on carbon sequestration in soil C pools. The modeled output based on the calibrated model fitted better to measured values than data obtained with the original Roth-C-26.3-model parameters. The main change was in the decomposition rate constant for the HUM (humified) soil C pool, which is now fitted for different plots from 0.005 to 0.01 y-1 instead of 0.02 y-1 as determined in the original Rothamsted field trial. Moreover, for one plot, in addition to the HUM pool, the decomposition rate constant for RPM (resistant plant material) pool was fitted at 0.7 y-1 instead of 0.3 y-1 as originally in the Roth-C-26.3-model. These changes yielded a higher HUM pool in the calibrated model because of the longer turnover period (100-200 versus 50 years). Compared with CR and SW treatments, the decline of TOC was largest in the BF treatments as expected because no significant carbon input has occurred since 1967. Nonetheless, the decline was still not as fast as calculated with original RothC-26.3-model decomposition rate constants.

The specific research question was the long-term effect of residue removal on SOM levels under different crop management, under different soil conditions and different climatic regimes of Fuchsenbigl (Austria), Rothamsted (UK) and Ultuna (Sweden). Modeling results of removing the crop residues showed that this can entail a long-term decline of SOM. However, these impacts are strongly dependent on the crop types, the soil properties, and the climatic conditions at a given location. Modeling results of the removal of crop residues showed that it can entail a long-term decline of SOM. A comparison of modeling results for winter wheat and spring barley for Rothamsted/UK, Fuchsenbigl/Austria and Ultuna/Sweden indicate slight SOC decreases at the Fuchsenbigl site when 100% of the straw was removed and increasing trends when 50% was removed. However, at the Rothamsted and Ultuna sites, 50% straw removal still resulted in declining SOC stocks.