A simple model of carbon in the soil profile for agricultural soils in Northwestern Europe

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Abstract:
World soil carbon (C) stocks are second to those in the ocean, and represent three times as much C as currently present in the atmosphere. The amount of C in soil may play a significant role in carbon exchanges between the atmosphere and the terrestrial environment. The C-TOOL model is a three-pool linked soil organic carbon (SOC) model in well-drained mineral soils under agricultural land management to allow generalized parameterization for estimating effects of management measures at medium to long time scales for the entire soil profile (0-100 cm). C-TOOL has been developed to enable simulations of SOC turnover in soil using temperature dependent first order kinetics for describing decomposition. Compared with many other SOC models, C-TOOL applies a less complicated structure, which facilitates easier calibration, and it requires only few inputs (i.e. average monthly air temperature, soil clay content, soil carbon-to-nitrogen ratio, and C inputs to the soil from plants and other sources). C-TOOL was parameterized using SOC and radiocarbon data from selected long-term field treatments in United Kingdom, Sweden and Denmark. However, less data were available for evaluation of subsoil C (25-100 cm) from the long-term experiments applied. In Denmark a national 7×7 km grid net was established in 1986 for soil C monitoring down to 100 cm depth. The results of SOC showed a significant decline from 1997 to 2009 in the 0-50 cm soil layer. This was mainly attributed to changes in the 25-50 cm layer, where a decline in SOC was found for all soil texture types. Across the period 1986 to 2009 there was clear tendency for increasing SOC on the sandy soils and reductions on the loamy soils. This effect is linked to land use, since grasslands and dairy farms are more abundant in the western parts of Denmark, where most of the sandy soils are located. The results and the data from soil monitoring have been used to validate the C-TOOL modelling approach used for accounting of changes in SOC of Danish agricultural soils and for verification of the national inventories of SOC changes in agricultural soils. Future work will focus on further evaluating effects on subsoil C as well as improving the estimation of C inputs, particularly root C input at different soil depth.

Key words: Soil organic carbon, modelling, C-TOOL, agriculture, management, grassland