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Quantifying the stable soil organic carbon: towards more accurate soil carbon models?

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In most soil organic carbon (SOC) dynamics models, SOC is divided into pools to which are ascribed different mineralization rates. SOC is usually divided in three main kinetic pools: a labile pool with a Mean Residence Time (MRT) of 1-5 years containing 0 to 10% of total SOC; an intermediate pool with a MRT of a few decades containing 30 to 80 % of total SOC; a stable pool with a MRT of a few centuries to several millennia containing 15 to 50% of total SOC (Smith et al., 1997). The lack of a reliable method to initialize the size of the different SOC kinetic pools is recognized as a clear limitation for the accuracy of SOC stocks evolution predictions provided by these models (Luo et al., 2016). In particular, SOC simulations are very sensitive to the size of the most stable pool (called inert, passive and stable in the Roth-C, Century and AMG models respectively), which makes the initialization of the size of this pool a priority issue (Falloon and Smith, 2000; Trumbore, 2009).
There were a few attempts to use results derived from soil fractionation schemes to initialize the size of the most stable pool of models but the proposed methods were not validated and are time consuming. As a result, they cannot be implemented on large sample sets, which make them irrelevant to large-scale modelling. Using an exceptional soil sample set from long-term bare fallow experiments in Western and Northern Europe, we showed that a machine learning algorithm based on Rock-Eval 6 (RE6) thermal analysis data can accurately predict the proportion of the pluri-centennial SOC pool in a soil sample with a prediction error lower than 6% for a wide range of temperate soils (Cécillon et al., 2018). We expect that this quick (less than 1 h per sample) and cheap (12 € per sample, consumable costs) method allowing to quantify the most stable SOC pool in any soil could significantly improve SOC dynamics models initialization. To this regard, our first results suggest that our method is suitable to initialize the AMG model in French cropped soils. The perspectives for the initialization of other SOC dynamics models will be discussed.

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