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Do we necessarily need to increase model complexity to forecast soil carbon dynamics?

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The importance of carbon fluxes between soils and atmosphere and their storage capacities have made soils a key component of nature-based solutions to mitigate climate change. Consequently, the need to forecast soil carbon dynamics at the decadal time scales is becoming a key research avenue for soil scientists and biogeochemists. One of the most important tools to fill this objective is the use of models, which have been developed and implemented since the mid- 20th century. Presuming that integrating more mechanisms would improve these models, some models of increased complexity were recently developed. Indeed, since roughly two decades, several approaches have been proposed to better represent the effect of some key mechanisms in particular related to soil biology and soil physics. For instance, few models are now able to describe explicitly and reliably the importance of soil microorganisms on the soil carbon dynamics from plot to global scale. Here, we will discuss what is the rationale behind model complexity increase, what are the limitations associated and discuss the status of evaluation for model prediction. In particular, we will show that despite model of increased complexity may provide accurate predictions in some conditions, those complex models also came with their own implicit assumptions and limitations that must be well understood before using complex models to forecast soil carbon dynamics and feed policy decisions. We also consider that models of lower complexity, which have been generally developed earlier, have also their own assets and have often been better evaluated. As a consequence, models of lower complexity may be considered as more robust and more adapted to forecast soil carbon dynamic and the improvement of their parameterization should also be considered as a valuable alternative. We will also present why multi model approach is important to reduce uncertainties and explain why using model ensemble, when implemented a diversity of carefully evaluated models, is a key method to forecast soil carbon dynamics. Finally, we will show that the fabulous growth of model complexity and the societal needs associated to soil is an incredible opportunity for soil scientists to increase the understanding of soil carbon cycle, in particular in the context of global changes, and to improve our future predictions on soil carbon.