

Interactive comment on “Modelling dynamic interactions between soil structure and the storage and turnover of soil organic matter” by Katharina Hildegard Elisabeth Meurer et al.

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We would like to thank Dr. Wutzler for his kind comments and for his valuable and constructive suggestions for improving the paper. We will provide responses to all the comments at a later stage, but here we would like to say a few words about the extremely interesting question he raised concerning a comparison of our model with a simpler model that does not account for the two-way interactions of soil organic matter (OM) with soil structure.

The simple two-pool ICBM model is obtained if the interactions between organic matter and soil structure are removed from our model. In principle, for the same parameteri-

C1

zation, the predictions of our model must diverge from ICBM for two or more treatments with contrasting OM input rates. This is because ICBM is strictly a first-order kinetic model, such that steady-state OM contents are a linear function of the OM input. In contrast, our extended model, which incorporates soil structure-OM interactions, does not show an exact linear response to OM inputs, and this non-linearity becomes more marked as the mixing between the pore regions becomes weaker. Nevertheless, successful applications of the ICBM model to the data from the Ultuna frame trial have already been published by Juston et al. (Ecological Modelling, 221, 1880-1888) for data available until 2007 and by Poeplau et al. (Geoderma 237/238, 246-255) for data until 2013. This paradox may be a consequence of the fact that for the duration of the frame trial, the departure from first-order behavior is not so apparent and is overshadowed by noise in the data. We will test how well ICBM can be calibrated to the extended dataset now available until 2019 and we will report these results in the revised paper. However, even if a simpler OM model such as ICBM can be calibrated satisfactorily to time-series of OM measurements at one site, our model that explicitly incorporates soil structure-OM feedbacks has many important advantages. This is because it enables simulations of the effects of soil structure and physical protection on OM turnover in contrasting soil types (e.g. sand vs. clay) explicitly and directly from measured particle size distributions, without having to resort to re-calibrating model parameters describing OM turnover for each soil, as was done, for example, by Poeplau et al. (Geoderma 237/238, 246-255). In principle, our model also has a much broader range of potential management applications. For example, it could be used to simulate the effects of contrasting tillage systems on SOC dynamics, as well as the effects of faunal bioturbation on OM stabilization.

We would also like to emphasize here that in discussing the importance of accounting for soil structure effects on SOM storage in simulation models, we should not ignore “the other side of the coin”, namely the importance of SOM for soil structure. We feel that the inclusion in our model of the effects of SOM on porosity, pore size distribution and soil water retention, is a very important advance compared to other models,

C2

because it enables straightforward links to models of soil hydrology, plant growth and therefore OM inputs to soil. This kind of dynamic soil-plant model would encompass, for the first time, a complete description of all the physical feedback mechanisms determining organic C sequestration in soil. We will expand our discussion of these important issues in the revised version of the paper.

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