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.

Anonymous Referee #2

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In this work, the authors propose a new framework to model soil organic matter turnover, which includes a two-way coupling between SOM storage and soil porosity. The model considers four pools of organic matter, with the dynamics described by four coupled differential equations. The novelty consists in using additional pools to divide the organic matter between micropore and mesopore soil regions, each one characterized by its own fluxes and decomposition rates. In my opinion such a model indeed can bring new insights about the dynamical feedback between soil physical properties and SOM decomposition, and can be an important contribution to the field. Although I find the paper interesting, I have some concerns. In particular I would have appreciated a more detailed discussion of the advantages of this new model.

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My recommendation is publication of this manuscript subject to a revision based on comments listed below.

1 - I find that the paper is in general well written, but the section with the description of the model is very confusing and needs to be improved. I would suggest to first write the full model including the feedback on porosity, and only afterward to follow with all the necessary derivations. Also, it is not clear by looking at the equations which parameters are kept constant, one has always to search in the text. One solution is to use upper case for functions and lower case for constants. Please also double check the notation, for example the density of mineral matter is γ_m on pg.6 and γ_{min} in all tables.

2 - The abstract states that the model successfully reproduces the soil water retention curves. I find this statement too strong due to the discrepancy of the curves for the year 1997.

3 - I would like to see an extended discussion on the k_{mix} and F_{prot}, since these parameters are at the core of the discussed feedback. For large values of k_{mix} and $F_{prot} \sim 1$ the soil structure properties have to become less important to the dynamics of SOM turnover. Could the authors comment on this transition to the regime where the soil porosity becomes less relevant for the model outcome? I would also appreciate a short comment on the choice of the sampled range for the sensitivity analysis (and also the choices for calibration).

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