**Biogeosciences
Discussions**

Interactive comment on "Measuring and modelling continuous quality distributions of soil organic matter" *by* S. Bruun et al.

S. Bruun et al.

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Thanks to Thomas Wutzler for a very qualified review and some excellent suggestions as to how we can improve the manuscript.

We are very happy that you think the paper has substantial scientific significance in model-data integration in the field of soil organic matter cycling. We still have so much to learn about the mechanisms that are protecting soil organic matter and contribute to its stabilization. The approach suggested in our paper is only one of many possible avenues which may be taken to do this, but we believe that this avenue hold some promising possibilities which is worth pursuing.

Thomas is right that the discussion of the parameter estimation is too general and

would be easier to understand if we added a concrete example. Therefore we have included an example where we have constructed some distributions of carbon as a function of density before and after experimental treatments with different inputs of organic matter. Subsequently some functional forms of k(q), D(q), and v(q) are chosen and the model is fitted to experimental data. Fig. 2 has been replaced with a new figure, which now illustrates this example. We agree very much that including this example has made the paper more illustrative and easier to understand.

We agree with Thomas that Part 5 which reviews fractionation methods in many ways resembles other reviews of fractionation methods. There is however the important distinction that we consider the usefulness of the fractionation methods for measuring a continuous distribution and consider modifications necessary to do so.

Thomas argues that a major improvement of the paper could be an enhanced discussion of how to disentangle and represent the different stabilization mechanisms. In response to this we have extended section 5.6 where we discuss the possible need for using several dimensions to capture all aspects of quality with an example illustrating how fractionation in two dimensions can be used to integrate information about several different stabilizing mechanisms for SOM. The Davidson and Janssens paper is very nice, but we cannot see that it is really relevant in our context because their focus is on what happens when an external variable, temperature, changes. Of course, temperature is important for us as well as it will modify all functions driving the changes in the distributions. However, it is not the purpose of this paper to go into details of how to derive these functions. We are also, but with a different perspective, taking up two of the stabilisation mechanisms that they indicate as important, physical and chemical protection, whereas water availability is entirely outside the our scope.

We agree that the introduction to Eq. 4 and the case of only allowing movement along the q-axis is a little abrupt. We have extended the explanations to make is less abrupt and easier to understand.

Thomas asks if the equations for isotopes requires that the Eq 6 is linear. This is likely to be the case, otherwise Eq(6) would also include terms in rho(q,t) and would probably be hopelessly complicated to handle.

As a response to p9051 l6, Thomas suggests that we give an example where it is applicable to have a decomposition rate that is independent of quality. However, this is certainly not what we suggest. In fact the whole purpose of introducing q is that the decomposition is dependent on it. What we assume is that k(q,t) it is dependent on rho(q,t), i.e. the amount of SOC with q. This means that respiration is proportional to the amount of SOC present and is a very common assumption in soil organic matter models, although sometimes questioned as detailed in the manuscript. To clarify this, we have expended the sentence with a little more explanation.

Thomas suggests that we add some examples of experiments that may be used for model calibration. We have added a sentence where we suggest experiments with varying inputs, tillage intensities and temperatures.

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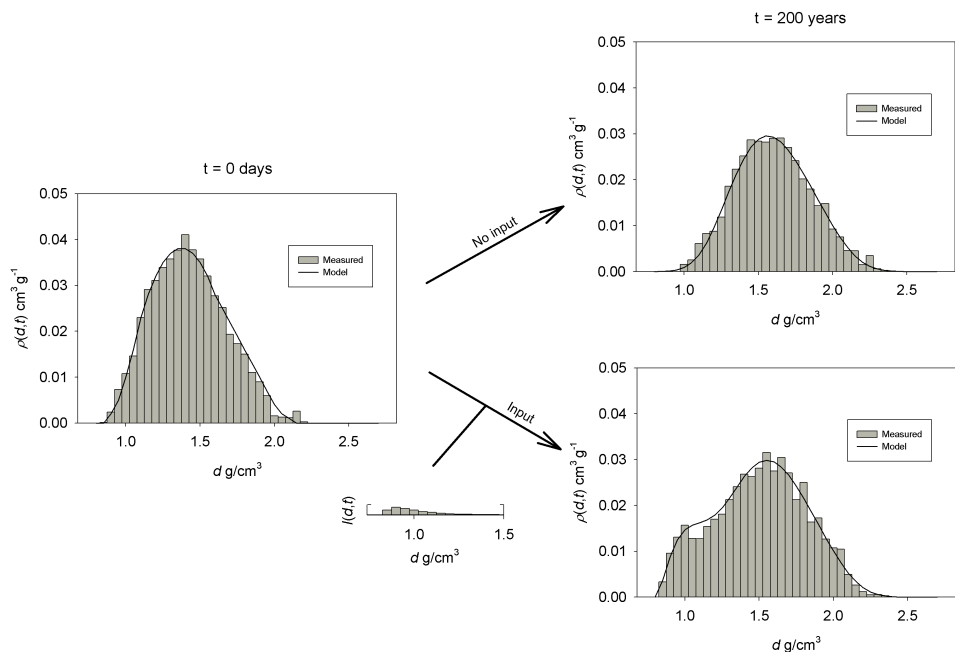
Discussion Paper

Fig 2: A constructed example of a model application where a density (*d*) distribution of C is measured on on a soil at time 0 years and again after 200 years of treatment with or without inputs of organanic matter. Subsequently a continuous distribution model is used to describe the development of the distribution and the parameters of the model is optimised to fit the observed data (see text for details).

Fig. 1. A constructed example of a model application