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Biogeosciences Discussions

Interactive comment on "Quality or decomposer efficiency – which is most important in the temperature response of litter decomposition? A modelling study using the GLUE methodology" *by* J. Å. M. Wetterstedt and G. I. Ågren

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We appreciate the comments from Referee #3 that have pointed out weaknesses in our presentation. It is clear that we have been too brief in the presentation in several instances. We suggest the following changes in the manuscript as answer to those comments.

General comments

Abstract. The referee indicates several points in the abstract. We propose the following

revised abstract, which also should give a clearer answer to the question in the title:

Effects of temperature history on litter decomposition were evaluated using the GLUE modelling framework together with the Q-model and data from a needle litter incubation experiment. The needle litter incubation was a full factorial design with the initial and final temperatures 5, 15 and 25°C. Samples were moved from the initial to the final temperature when approximately 12% of the initial carbon had been respired and the experiment terminated when an additional 12% had been lost. In the Q-model litter is described by a quality that changes during decomposition. Quality and temperature determine together the growth rate of the decomposers in such a way that the temperature sensitivity of the decomposition rate decreases with increasing substrate quality. We used four variations of the Q-model; the litter was described as having one or two initial quality values and the decomposer efficiency was either fixed or allowed to vary with temperature. All variations were calibrated with good fits to the data subsets with equal initial and final temperatures. Evaluation against temperature shift subsets also showed good results, except just after the change in temperature where all variations predicted a smaller response than observed. The effects of having one or two initial litter quality values (fixed decomposer efficiency) were marginal on end-of-experiment litter quality and respiration. Letting decomposer efficiency vary with temperature showed a decrease in efficiency between 5 and 15 °C but no change between 15 and 25 °C. Using those efficiencies also resulted in substantial differences in litter quality at the end of the initial incubation in response to incubation temperature with consequences for the incubation at the final temperature. The temperature response of decomposition through temperature dependent decomposer efficiency proved, therefore, to be more important than the differential response to different substrate qualities. These results suggests that it may be important to consider other factors (e.g. microbial efficiency, changing substrate composition) than the temperature sensitivity coupled to substrate quality when evaluating effects of temperature changes on soil organic matter stability.

We have expanded the presentation of the GLUE framework at the end of the Introduction to:

We have chosen to use the GLUE (Generalised Likelihood Uncertainty Estimation, Beven, 2006) framework for model calibration and evaluation. GLUE can be used as a modelling protocol and is well suited to give uncertainty estimations in model output. It also provides criteria for complete model rejection, i.e. the model structure needs to be changed if the model fails to predict empirical data well enough.

The main reason for choosing GLUE as opposed to a formal Bayesian approach was because it allowed us more freedom in specifying a likelihood function. The measurements are known to contain equipment-related errors, there is biological variation within the replicates, the Q-model is non-linear, and the ever present model structural error makes the identification of a formal error model to be used in a formal Bayesian approach problematic. Moreover, our main purpose is not to establish the value of the parameters to the best precision possible, but rather to explore qualitative effects of the parameters and the model. Using GLUE, it is often the case that quite different parameter sets give more or less equal good fits (equifinality). Within the framework it is easy and straightforward to use those sets in ensemble modeling. Even though the likelihood function is subjectively chosen it is easy to understand and communicate to a wider audience. The likelihood function is of lesser importance as long as it will help us find parameters that make the model predict measurements well. See also the discussion of the use of the GLUE methodology versus other formal Bayesian approaches (Mantovan & Todini, 2006; Beven et al., 2008).

New references Beven, K.J., Smith, P.J., and Freer, J.E.: So just why would a modeller choose to be incoherent? J. Hydrol. 354, 15-32, 2008. Mantovan, P. and Todini, E.: Hydrological forecasting uncertainty assessment: Incoherence of the GLUE methodology, J. Hydrol. 330, 368-381, 2006.

We will add to the end of the presentation of the Q-model (Section 2.1) the following

text to explain the reason behind Figure 6: Besides answering the question of which variations of the Q-model that can reproduce the observations it is necessary to look at the consequences for the distribution of carbon qualities; when extrapolating from this short-term experiment to long-term carbon storage differences in quality distributions become important.

The choice of initial qualities was also addressed by another referee (T Wutlzer) and we suggested the following changes to the last paragraph of section 2.1: “Four versions of the model were run with combinations of one or two initial qualities combined with fixed or flexible decomposer efficiencies. When using two initial qualities, one quality was chosen as the best one found when using only one quality and the other one was set to lower value estimated to give a reasonable difference; the sensitivity to this choice was also tested. The initial amount of carbon was partitioned equally between the two qualities.”

Specific comments

Introduction:

We have rewritten the paragraph in the introduction as follows: To investigate how the factors quality and decomposer efficiency affect respiration at different temperatures (temperature response) we tested the Q-model (Bosatta and Ågren, 2003; Ågren and Bosatta, 1998) against an incubation experiment with needle litter (Wetterstedt et al., 2010). The Q-model was chosen because the fate of carbon and the decomposition processes are relatively easy to follow in it. The factors quality and decomposer efficiency are explored by modifying the model to have one or two initial litter qualities in combination with fixed or flexible (with regard to temperature) decomposer efficiency.

Results:

P8708 L6: where should be were Yes.

We define our definition of behavioural models now in Section 2.3.1 where have added

a sentence: However, this turned out not to be feasible, why have chosen LM > 0 as criteria for a behavioural model.

As a consequence we need to modify the second paragraph of Section 3.1 by deleting its two first sentences and in the first paragraph of Section 3.2 deleting the text ", i.e. with LM > 0"

P8708 L21: Should with be by? Yes.

P8710 L4: The effect of efficiency and quality on what?

We rewrite this sentence as: Since the primary objective of this paper is not to model decomposition in general, but rather to highlight the effects on quality composition and respiration rates of a temperature-dependent efficiency and the coupling of quality with temperature, . . .

Discussion:

P8712 L23-24: I think this should read "If decomposer efficiency goes down with increasing temperature. . .". Yes.

Figure 5: keep the terminology fixed and flexible for eo rather than one and several. We do not understand this comment. We have not used the terms one and several in this Figure.

Interactive comment on Biogeosciences Discuss., 7, 8699, 2010.