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Biogeosciences Discussions

Interactive comment on "Predicting decadal trends and transient responses of radiocarbon storage and fluxes in a temperate forest soil" *by* C. A. Sierra et al.

S. Bruun (Referee)

sab@life.ku.dk

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General comments

The data presented in this paper regarding the effect of nitrogen and temperature on the ^{14}C content of the respiration and soil fractions are rather uncertain and very difficult to interpret. Therefore you may ask whether the data are at all suitable to use for model testing and testing of different hypotheses regarding the effect of these temperature and N manipulations on decomposition of soil organic carbon. The authors are well aware of these limitations, however, and in conclusion I believe that the study provide some insight in the difficulties that we are facing when we are trying to test models and

hypotheses about long-term effects of environmental changes on carbon stocks and dynamics.

Specific comments

I disagree with the way you are defining decomposition rates. I my understanding, the unit of a decomposition rate would be an amount of C per unit time e.g. mg yr^{-1}, which would be in line with the usual definition of reaction rates in chemistry. The decomposition rate of a soil C fraction will thus depend on the amount of C in the fraction. You seem to define the rates with the unit yr^{-1} which is what I would usually call a decomposition constant corresponding to a reaction rate constant in chemistry. This confusion makes several paragraphs difficult to understand.

Page 2199, line 18-21. I agree that the equilibrium assumptions are challenged in the situations that you mention. However, in addition to the mentioned situations there are many situations where the assumption is challenged because of changes in land use or management, the most noticeable being changes from natural grass or forest into agriculture or vice versa. I think this is worth mentioning here as well.

Page 2202, line 6. I think it is good to mention that these hypotheses are alternatives. I found myself thinking. They cannot possibly think they are all true when I was reading them the first time.

Page 2202, line 6-25. The hypotheses are not clearly formulated and very difficult to follow. I think it would be good to introduce some equations here or maybe show figure 2 at this stage, in order to define the hypotheses more clearly. Line 8: what is meant by treatments? Line 15. What is meant by “Arrhenius kinetics” I believe what you mean is the “Arrhenius equation”. This law defines how the rate constant of a chemical reaction is influenced by temperature. I believe that what you are talking about is how the rate constant is affected by its turnover rate? Or decomposability index as defined in Figure 2? This is impossible to understand from the way it is described here.

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Page 2204, line 16: Can you trap CO_2 with stainless steel? You need to explain in a little more detail.

Page 2204 line 26: Did you test how accurate the assumption of atmospheric concentration and isotopic composition of the air in the beginning of the incubation was?

Page 2206, line 12: “heterotrophic and soil respiration”. Most soil respiration would be heterotrophic. Do you mean “heterotrophic soil respiration”?

Page 2209, line 15. Something is wrong in this sentence “radiocarbon contents of the different soil horizons fit with the model predictions”. First of all I believe it is not correct English and then what you depict in Figure 3 is really soil fractions and not horizons. Finally I am unsure how good the fit actually is? I have nothing to hold it up against. It is better than the average of the measurements at the two sampling times?

Page 2210, line 15. It is unclear to me how you found the amounts of C in the pools in Figure 6. Is it the amounts measured? Or is it the amounts predicted by the model at equilibrium?

Section 3.4: There are no significant differences between $\Delta^{14}C$ values of respired CO_2 from the different N and temperature treatments (Figure 4). In addition, you only found a significant deviation of the $\Delta^{14}C$ value in control from the other treatments in the mineral soil after two months and not at any of the other sampling times. This appears rather odd and is difficult to explain. If the effects of the treatments are not significant and the results difficult to interpret because of uncertainties one may well ask if the data are suitable for model validation and hypothesis testing regarding the effects of N and temperature treatments.

Page 2210, line 28: Why did you choose to increase the decomposition rates (or contacts) with a factor of 1.5? This seems rather arbitrary and if another value had been chosen, the conclusions might have been different?

Page 2211: You seem to forget to comment on Figure 9.

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Page 2213, line 6. As stated earlier, I am unsure how good the fit in Figure 3 is and therefore unsure about the predictive power the authors refer to here.

Page 2215 line 8 to 25. As you state yourself the variability of the data is so large that it is impossible to decide which warming x N treatment effect hypothesis is the best. In fact none of the hypothesis seems to be able to explain the observed changes in Fig 8. This however questions the usefulness of the data for validation of these hypotheses.

Page 2215 line 26 to 2216 line 7. Conceptually is do not like the idea of changing the distribution between pools in response to changes in climate. Supposedly, these fractions should correspond to some physical fractions which actually exist in the soil and how can physical fractions possibly change instantaneously in response to changes in temperature. Imagine the dynamics of such a model under a fluctuating temperature regime. Also, the evidence in Figure 9 is hardly enough to suggest such comprehensive changes to the model.

Page 2217 line 9. You state that the model was able to simulate most, but not all the data from temperature and nitrogen manipulation experiments. I would rather say it was unable to simulate most of the manipulation experiments.

Interactive comment on Biogeosciences Discuss., 9, 2197, 2012.