

Interactive comment on “Interactions among temperature, moisture, and oxygen concentrations in controlling decomposition rates” by Carlos A. Sierra et al.

Anonymous Referee #3

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General comments.

Interactive controls of multiple environmental factors on the decomposition of soil organic matter, and its loss to the atmosphere, remains a challenging research question despite much effort by the research community. This study presents a useful factorial experimental manipulation of temperature, water, and most interestingly [O₂], to evaluate the interactive controls of these factors on C loss in from boreal forest soils. The choice of soils probably limited the effect of substrate limitation, and also represents a pool of C (boreal forest soil C) that is potentially a major contributor to future feedbacks between climate and the terrestrial C cycle. The data-model integration is a useful effort, and I like that the authors present the data and code, as it will very likely be

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useful to other researchers. However, I think the paper needs to present the modeling approach and the results somewhat more clearly. Also, the results and discussion seem a little sparse on several of the key questions the authors introduce. The writing is clear, although I think the paper contains several ambiguities related to the brevity. Some features need to be described in more detail.

Specific comments.

P1 Line 7: The site is boreal, not arctic.

P1 Line 9: The conclusion about temperature effect need to be tempered or qualified in the context of the limited range of temperatures evaluated.

P1 Line 10: This is a significant conclusion, even though it seems relatively obvious-having a good experimental design to say this conclusively is useful.

P2 Line 4: How does this 45C threshold correspond to your high temperature? Is 45C broadly constant across ecosystems?

P2 Line 24: True, and a major strength of this study.

P3 Line 8: Again, boreal, not arctic.

P3 Line 9: This statement is not necessarily true depending on the content of labile, readily respired substrate. It should be explored a little further and contextualized with other studies that evaluate substrate limitation of soil respiration in organic soils, especially from boreal regions.

P3 Line 18: It is unclear exactly how this measurement was used to evaluate the soil respiration or decomposition rate. Can you please clarify? Was it evaluated as change over a set time interval, or as increase over the known background from the input air? At what frequency was this measured?

Eqn 1: Please be clear about what exactly dC/dt represents. Is it the instantaneous or the cumulative dCO_2 , is it CO_2 or CO_2-C ?

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P4 Line 10: Does this mean that gamma also varies by each treatment level? And initial C1 and C2 also vary by treatment level? I would like to see some presentation of the actual C fluxes, and the change in C1 and C2 over time.

P4 Line 12: Fitting the full model in eqn 2, is gamma now fixed? Also, are there limitations to fitting a q10 function with only two temperature points?

P4 Line 14: Thanks for presenting this supplement.

P 4 Line 27: I am more surprised at how similar the k1 and k2 values in Fig 2 are across such a broad range of O2: Can you explain this result more clearly.

P5 Line 5: Can you please elaborate a little further on fig 3? We do see a few seemingly high correlations that might be worth describing in more detail. For instance, Ko and ks.

P5 Line 6: Am I missing the posterior parameter estimates? It would be very useful to have a table of these parameter values and credible intervals.

P5 Line 7: Why did you use this range rather than the 2.5-97.5? It looks like your estimates of the temperature function might be challenging in that case, which isn't that surprising with only two temps. I think it is worth revising these figures to have both the 25-75 and then standard 95% credible interval presented.

P7 Line 1: The discussion should give some analysis of the temperature response. In particular, how do the estimated q10 values compare to other q10 values using soils from similar boreal forest sites? Also, what is the temperature range at this site? You describe the 45C threshold in the introduction, but then use a much lower temperature as the high temp. Is this higher than temperatures the soil organisms at this site regularly experience? Is it higher than projected future temperatures for this site?

P8 Line 3: Can you please describe some of these interactions more specifically? It seems as though a lot of the work is presenting marginal responses. Is there some reduction of temperature sensitivity at high water content? or a reduction of oxygen

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sensitivity at low water content? Please clarify what interactions you mean.

P8 Line7: I am not sure I follow. Looking at figure 1, most CO₂ was respired at high water content. Are you thus comparing the low to the high oxygen rates, and then inferring a response in the absence of continuous oxygen flow? Please be explicit about that.

P9 Line 3: Perhaps discuss more thoroughly how the inclusion of dynamically changing air-filled pore space might relate to your results. This is a suggestion, not a necessary revision.

Technical corrections

P1 Line 16: *significantly

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