

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

Anonymous Referee #2

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This manuscript addresses the response of decomposition to three important environmental factors that are closely linked to global change in a very comprehensive way, by performing a multifactorial laboratory study on C rich Arctic soils using a broad range of temperatures, moisture and oxygen concentrations. Even if the effect of these three single factors on decomposition has been extensively studied, combined responses are not yet well understood. A better understanding of interactions between effects of these factors on decomposition is important, as global change is expected to affect all three factors simultaneously in many regions during the next decades. Moreover, changes in decomposition rate can exert strong feedback mechanisms to the climate system, especially at high northern latitudes, which contain both the highest amounts

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of soil C and are exposed to the strongest warming.

The conclusions from this research are not highly surprising ((1) temperature stimulates decomposition, but only if moisture and oxygen are available in sufficient concentrations and (2) the oxygen limitation is the main cause for decreasing decomposition rates at high moisture levels). However, a comprehensive study, investigating a broad range of moisture and oxygen levels at different warming levels was still lacking, and gives a more solid base for projections. The manuscript is well written and concise and is easy to follow.

Below, I list my few comments and suggestions on the manuscript:

p. 3, line 5:

The soil columns contained 450 g of homogenized soil. It would also be good to have an idea of the dimensions of the columns (diameter, height). This determines, for instance, the surface area that is subjected to drying and the distance that the oxygen flow travels through the sample. Further, an estimate of the bulk density of the soil or of the proportion of pore space in the samples would be helpful. It is especially important that the pore space was similar for all soil columns so that differences in diffusion potential of oxygen, water and temperature does not influence the results.

p. 3, lines 9-11:

One of the reason to choose Arctic soils that is mentioned is the “low temperatures at which its microbial community is constantly exposed”, which “facilitates the possibility of observing strong responses at the extreme of the temperature range”. I agree that one would expect a strong response of the microbial activity after step-increasing the temperature by ~ 20 to 40°C , but the reaction might be more related to stress physiology than an actual temperature response, especially during such a short treatment period (35 days). Therefore, I would not stress this point too much and briefly touch the issue with stress responses after drastic step-change in environmental factors in

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the discussion section.

Additionally, I suggest to add another advantage of using Arctic soils for this incubation study: The large amounts of C stored in the Arctic region in combination with the fast warming (compared to the global average). Also moisture (and oxygen) is an issue in that region because of the impenetrable permafrost layer that is present under a large part of the surface.

Further, it is important to restrain your conclusions to Arctic soils, as their dynamics might differ from soils from more moderate or tropical climates. For instance, it has recently been shown that the C balance of soils from Arctic and subarctic regions are more sensitive to warming. It might be that the influence of moisture and or oxygen (and especially the interactions) differ between climates (and probably soil types, but it would dilute the story too much to dig deeper into this). It would be very interesting to perform a similar study with soils from different climate regions.

p. 4, line 4-6 and 24-25:

The fractionation of slow and fast cycling C pools (with different decomposition rates) is not well introduced. Add a paragraph in the introduction as rationale why it is interesting to separate into slow and fast cycling pools when investigating temperature, moisture and oxygen effects on decomposition rates. Also, expand the discussion on this subject.

p. 4, line 4-6:

Define T, W and O.

I would also change W (Water) into M (Moisture), which fits better with the title.

p. 4, line 21 and 22:

35, 90, 20 and 25, 15, 1: Add units to the numbers.

p. 6, line 3-4:

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“Decomposition rates were highly sensitive at a narrow part of the oxygen range, while for moisture this range was wider (Figure 4).”

The oxygen range in this study covered the full range of oxygen that can be expected, from 1% (anoxic) to 20% (the maximum that can be expected; atmospheric O₂ concentration). The range with the highest sensitivity to oxygen in Figure 4 runs from 0 to 2.5%, which is about 12.5% of the range.

Also for moisture a broad range is covered (15 to 90%). The range with the highest sensitivity to oxygen in Figure 4 runs from 0 to 10%, which is about 11% of the range (if the maximum is set to 90%).

As there is little difference between 12.5 and 11% of the range, I do not understand the statement that the sensitivity to moisture occurred at a broader range. Can you explain this in more detail?

p. 8, Figure 4:

It is strange that the strongest response for all three parameters occurs outside the treatment range of this study. Is it possible to extrapolate your findings that far?

p. 1 line 7; p. 3 Lines 9; p. 9 line 8

Change "arctic" into "Arctic"

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