SOIL Discuss.,
doi:10.5194/soil-2017-5-AC2, 2017

Interactive comment on "A deeper look at the relationship between root carbon pools and the vertical distribution of the soil carbon pool" *by* Ranae Dietzel et al.

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Received and published: 19 May 2017

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A note upfront from the submitting person: This review was prepared by Nadja Huber and Mirjam Mächler, both master students in geography at the University of Zurich. The review was part of an exercise during a second semester master level seminar on "the biogeochemistry of plant-soil systems in a changing world", which I organize. We would like to highlight that the depth of scientific knowledge and technical understanding of these reviewers represents that of master students. We enjoyed discussing the manuscript in the seminar, and hope that our comments will be helpful for the authors.

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Discussion paper

That is so great that you discussed our paper as a group! What a great exercise and these comments are just the sort of thing we hoped would happen when submitting a paper to Soil. Thanks a lot for your comments. Hearing from many people really makes obvious which portions of the paper are difficult to understand and where the most improvement is needed.

Dietzel et al. start with the fundamental statement, that soil organic carbon and root mass are disproportionately distributed in soils, supposing that root mass has a direct influence on soil carbon pool. As a matter of fact, in a depth below 20cm half of all soil organic C in soils can be found where just a third of all root mass is. There is no clear answer to the question, why there is such a large difference between the two C pools. Dietzel et al. mention that temperature, moisture, O2, soil texture and soil C values are part of the explanation of this discrepancy. Still, the C:N ratio as part of it has always been neglected in previous studies.

Indeed, decreases in root C:N ratio with depth has been an unknown factor.

The paper therefore specifically concentrates on a more detailed look at the properties of C pools. For this purpose the authors examined soil C and root C pools in three different cropping systems. Continuous maize, multispecies prairie and N-fertilized multispecies prairie. Research questions asked were the following: “1) How does the quantity, distribution, and C:N ratio of the root C pool differ with depth and between these native perennial and non-native annual ecosystems and 2) what do these differences in input tell us about the historical belowground ecosystem under which these soils developed and the systems and will these soils continue to change?” To answer these questions the authors conducted a field experiment over six years in Boone County, IA, USA. With this field experiment the authors were able to show that an increase in root C:N ratio with depth is a potentially important factor determining the distribution of C in the soil profile. The authors consider the root pool C:N ratios to be sufficiently important that they result in a greater maize C contributions to soil organic matter than prairie C below 20 cm.

Objective 1 (root quality and quantity with depth) was discussed in detail in the manuscript.

During the discussion in the classroom, however, it became clear that objective 2 and the related discussion confused all of us. We did not understand i) why the “historical belowground ecosystem” is important

Reviewer 1 also brought this to our attention. This sentence needs to be reworded to be more explicit for a broader audience. The ’historical belowground ecosystem’ is the prairie systems under which the soils formed.

and ii) how objective 2 relates to the presented results. The question if these soils will continue to change is rhetoric (soil always continue to develop) and very unspecific.

Yes, this part of the sentence will also be reworded. We did not mean ’if’, but ’how’ soils will continue to change under annual cropping systems compared to reconstructed perennial systems.

The corresponding discussion section (4.3) is very short and speculative. Are root “turnover” (with a lifetime of a few years) and soil organic carbon turnover (decades to centuries) somehow related?

They are definitely related. Where does soil organic carbon come from? As roots cease to be roots, they turn into CO2 or organic matter, influencing soil organic carbon turnover on the scale of days to centuries, even thousands of years for soils that have been occupied by roots for thousands of years.

Probably they are not. Coincidence is not causation. We wondered if objective 2 and section 4.3 are needed at all. If you think they are, please elaborate this part of the manuscript.

Yes, we will certainly elaborate on this.

Detailed comments: We did not fully understand the link between C:N and root depth.

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Do you mean that C:N ratios increase with depth depending on species or on individual plants?

As we move deeper into the soil, root C:N ratios increase for all plants in this study.

P. 3, line 26: what does “sampling by replicate block from 31 October-25 November 2008” mean? Did you sample repeatedly? Explanation of “replicate block”-approach needed.

Yes, this is not clear and we will add more details.

P. 4, line 11/12: is there a difference between root measurements and root data?

Yes, there is. We should not have used them interchangeably here. Thanks for catching that.

P. 4, line 24/25: why different storage? Further explanation desired.

We explain that storage was different because soil from the first year was part of an incubation experiment.

P. 5, line 28: why the period between April 1st and November 30th to calculate the average root mass accumulation? Are these official dates? Further explanation needed.

These dates are the approximate window for plant growth in our region. We will include that information in the manuscript.

Table p. 10: unclear -> explanation of upper/lower case letters and meaning of those letters is missing; it could be part of the description of the table

This information is in the caption. Perhaps it did not come through with the format you were looking at.

Explanation pro glimmix on page 5/14 but not in table description.

Thank you, but not sure what you are looking for here.

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P. 13, line 3: increase in root pool C:N ratio has not been reported previously in the literature: We would appreciate some information about previous research which focused on a related topic

We literally could not find any literature related to root pool C:N ratio.

P. 14, line 3/4: the pattern of distribution of what? Do you mean the vertical distribution of roots? What is place in this context?

Pattern of distribution of roots. We will add this to the text.

P. 14, line 30-32: For us, this sentence is very long and difficult to understand. No significant changes in soil C (changes in quantity or stocks?) at any depth but differences in quantity?

We will split this sentence up into segments that are easier to understand. No changes in soil C despite changes in root quantity.

"implementation of annual cropping systems": Do you refer to line 19? Experimental location was a site of cultivation under annual crops for over 100 years.

These soils were dominated by prairies for 10,000 years, so the shift to annual cropping systems 100 years ago is still relatively recent in terms of soil development. This information is important for us to add to the text.

Remarks concerning formal structures (typos, figures etc.):

P. 3, line 2: typo: 11 mg kg-1

Thanks.

Figure p. 6: why not making a title with total C, root C maize, etc. instead of letters a,b,c -> would be more clear and consistent with the following figures

Yes, we can change this.

Figures p.8 + 9: legend can be improved -> no units -> unclear & colors are not suitable

for black/white printing

We will add units to the legend and we used to different linetypes for different treatments in black and white printing, but see now that is not obvious.

P. 13, line 36: typo: this

Thanks.

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