

Interactive comment on “Differences in spatial and temporal root lifespan of temperate steppes across Inner Mongolia grasslands” by W.-M. Bai et al.

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Received and published: 31 January 2016

We are highly appreciative of the constructive criticisms and comments by the four reviewers on our manuscript (Biogeosciences Discuss., 12, C8968–C8972, 2016). We have done an extensive revision and included additional results as suggested by the reviewers. The changes are highlighted in blue color in the revised manuscript. The detailed point-by-point responses to the reviewers' comments are given in the following section.

Anonymous Referee #1

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The work by Bai et al presents novel data regarding differences in fine root lifespan across distinct types of grasslands within the inner-Mongolian steppe. The major finding was that there were significant differences in fine root lifespan across these sites. This is important to recognize as most models would generally treat these sites as equivalent. The authors also observed consistent differences in lifespan among roots born in different seasons. Overall, the manuscript was easy to follow and understand, despite some persistent, small grammar mistakes throughout (I have pointed some, but not all of these out in my detailed comments below). While the data collection, presentation, and interpretation were largely sound, I did have a few significant criticisms that may be addressed.

We appreciate the positive comments on our study by the reviewer.

First, the authors placed particular significance on the relationship between root lifespan and soluble sugar content. While this measure can be important, it is also known to be highly variable due to both methodological issues with carbohydrate analysis as well as high variability in root concentrations through time and in response to environment. To ensure that comparisons were accurate, it would also be important to know that sampled roots were all of approximately the same age. At the same time, there was no mention of more commonly observed/measured metrics of root traits related to root lifespan (i.e. root diameter, SRL, N content, et.). Were these measure at these sites, or for the dominant species? Additionally, the emphasis on root soluble sugars seemed odd given the fact that the usefulness of the variable may be limited to root focused studies. Yet, other variables measured at the sites, ANPP perhaps most important among them, were also strongly related to the differences in root lifespan, but these results were not emphasized and discussed to the same degree. In summary, the emphasis on soluble sugars may be acceptable, but it will require more justification. Otherwise, I would suggest emphasizing other variables as well and not focusing quite so much on the sugars

In the determination of soluble sugar contents, the first and second order of roots at the

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end of root branching were used for determination of soluble sugar contents. This may minimize the variations of measured root soluble sugar contents caused by the root age. We also measured N contents in roots, ANPP, BNPP and the ratio BNPP to ANPP (BNPP/ANPP), and analysed the correlation between root longevity and N content in roots, and between root longevity and ANPP and BNPP/ANPP in the revised Figure 5 (Fig. 5e, 5f). Our results showed that BNPP/ANPP and soluble sugar contents in roots can explain 66.13% variation of root longevity (lines 310-316).

P 20000, line 10: awkward phrasing “using the rhizotron” , either “using rhizotrons” or “using the rhizotron technique” would be better

We changed the sentence as suggested by the reviewer in the revised manuscript (line 29).

P 20000, line 16-17: it would be useful to know in what way soluble sugars was related. For example, was higher soluble sugars positively related to lifespan?

We revised the sentence by adding “such that roots with high soluble sugar contents exhibited longer root lifespan” as suggested by the reviewer (lines 36-37).

P 20000, line 22: Roots are

Yes, we made the change accordingly (line 46).

P 20001, line 19: In particular,

Yes, we fixed the typo.

P 01, line 25-26: “determined in a limited types of community” the grammar here is incorrect, but more importantly, I am not sure what the intended meaning is.

We re-worded the sentence to “Moreover, a single value of root lifespan or root turnover of limited types of community within a ecosystem has often been used to predict the ecosystem C.” (lines 74-76)

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P 01, line 27: the way this is written, the “and reliable” part could be misinterpreted. Probably easiest to just delete that part, or you could partially rephrase the sentence.

We changed the sentence as suggested by the reviewer in the revised manuscript (line 77) .

P 02, line 2-4: this sentence seems to just repeat the previous sentence.

Yes, we deleted the sentence.

P 02, line 9: here and throughout, would hm2 be more normally expressed as ha?

We replaced “hm2” by “ha” thorough out the manuscript (line 86).

P 03, line 25-26: you give the average January and July temps for the other grasslands, why not for this grassland?

Yes, we included the average January and July temperatures for this grassland.

P 03-04, section 2.1: Because so much emphasis is placed on the individual species *S. breiflora*, *S. grandis*, and *S. krylovii*, it would be very useful to know approximately what proportion (either biomass or total area) of each grassland type is dominated by the relevant species.

The aboveground biomass of *S. krylovii*, *S. grandis*, and *S. breiflora* can account for their communities 74.33%, 60.68% and 58.96%, respectively. We now include this information in the revised manuscript (lines 146-148).

P 07, line 10-12: I may be confused, but why were all roots not considered if they were observed. It seems like only roots that fit into arbitrarily defined seasons were used. Was a significant proportion of roots born outside of those seasons? Were there any specific criteria used to define seasons (Spring and Summer are _30 days, but Autumn was only _20).

We revised these sentences by including the total number of roots used for evaluation

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of different grassland types on root longevity (lines 236-242).

P 08, line 4: delete “were”

We deleted “were” in the revised manuscript.

P 08, line 5: delete “s” in soil organic matter”s” here and throughout.

We delete “s” in the revised manuscript.

P 08, line 23: currently reads, “S. grandis, S. grandis and S. breviflora”, should “S. krylovii” be first? Also, this references Table 1, but there is no lifespan information presented in Table 1. Should the reference be for Figure 2 instead?

The sentence was revised accordingly (line 277).

P 09, line 5-6: the value/meaning of this sentence is somewhat unclear. What do you mean by comparable? They were similar?

We changed the “comparable” to “similar” as suggested by the reviewer (line 282).

P 09, section 3.3: It might be useful and interesting to give a sense of what proportion of roots were born in each season and how that contributed to overall differences in the root lifespan for a particular grassland. For example, how much of overall longer lifespan observed in the S. breviflora grassland was due to the roots in each season living longer than the other grasslands vs. there simply being a higher proportion of roots produced in the autumn season, which for all grassland types was the season with the longest root lifespan? Unfortunately, this comparison does have the problem of the seasons being arbitrarily defined.

We agree with the reviewer that the comparison of longevity of roots born arbitrarily defined in different seasons is not the best way to determine the differences in root longevity among different seasons. However, there is no alternative way to quantify the roots born in different seasons at the moment, and we have to use the local climate for arbitrarily assigning roots in different seasons.

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P 10, line 9-11: It is OK to use the plot replicates (i.e. 3 grassland types x 6 replicate plots) as independent points in the regression? Please justify. Maybe OK, assuming that there were independent estimates of soluble sugar content from each plot, but still suspect.

Yes, the use of plot replicates in different grasslands as independent points in the regression is justified.

P 10, section 3.5: based on the individual regressions presented in Figure 5, ANPP actually had a higher r-squared than soluble sugar. Why not emphasize that finding more, especially given the fact that the ANPP relationship would be much more useful for modelers as the models will incorporate or predict estimates of ANPP, but will not likely have estimates/parameters for soluble sugar content in roots.

We revised the Figure 5 by including the correlation between root longevity and root N contents, and root longevity and BNPP/ANPP. We further demonstrated that BNPP/ANPP can explain 66% of variation in root longevity by stepwise regression (lines 310-316).

Results section: were any of the more general site variables listed in Table 1 considered as covariates? What about temperature and precipitation across the sites? Even if none of these factors are significant, the findings should still be mentioned in the Results

We include the statements that soil pH, available P and K content, bulk density and water content were not significantly correlated with root longevity in the revised manuscript (lines 311-313). The temperature and precipitation across the sites were given in the section of 2.1.

P 10, line 18: “no consistent pattern” this is not a particularly useful statement. Moreover, your results that there might actually be consistent patterns across these grasslands (e.g. there were consistent patterns with soluble sugars, SOM, inorganic N con-

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tent, and ANPP.

To make the sentence more concise, we deleted “and that no consistent patterns for root turnover in different types of grasslands . . .” in the revised manuscript.

P 10, line 20-23: How did you estimate turnover from your lifespan estimates (no description or equations were given)? For species whose root lifespans are consistently less than 1 year, turnover should not be calculated as a direct inverse of lifespan. Root lifespan and turnover are not the same and species with different lifespans could have the same/similar turnovers. Conversely species with similar root lifespans could also have different turnovers. Without information of how the 48.6% estimate was reached, it is very unclear whether it is valid or meaningful.

The root turnover rate was re-calculated using the data of root length production and root length standing crop. We included this information in the revised manuscript (lines 326-329).

P 11, line 15: I believe you mean “interweaving” instead of “interleaving”

We made the change accordingly (line 348).

P 12: This is a good paragraph, but is a bit long which makes it difficult for the reader to maintain focus. I would suggest splitting, perhaps at line 12, where the focus of the paragraph shifts somewhat from intrinsic factors to more environmental factors.

We splitted the paragraph into two paragraphs as suggested by the reviewer (line 373).

P 12, line 22: the McCormack and Guo study is a review article. In the context of this sentence, you would be better served citing the primary literature mentioned in that review.

We included several primary literature as suggested by the reviewer in the revised manuscript (lines 384-385).

P 12-13, line 26-2: it is unclear why this is the overall summary of the paragraph (i.e.

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focusing only on soluble sugars) when there were many other factors that seemed equally if not more important (e.g. ANPP).

We deleted this sentence in the revised manuscript.

P 13, line 17: “in contrast” is maybe not the right phrase since the results were qualitatively the same among seasons, i.e. not in contrast.

We revised the sentence by replacing “in contrast” with “similar to” (line 408).

P 14, line 6: should be “phenological” not phonological.

The typo was fixed (line 427).

Figure 2: It might be good to indicate the different species by different shapes for each point in case readers print the figure in black and white, or in case readers are color blind. Something like squares, circles, and triangles for *S. krylovii*, *S. grandis*, and *S. breviflora*, respectively, would work.

We revised the Figure 2 and Figure 3 following the suggestion made by the reviewer.

Figure 5: it would be very useful to indicate the different grassland types on each figure, maybe using different shapes for the data points (e.g. square, circle, triangle for *S. krylovii*, *S. grandis*, *S. breviflora*, or possible match shapes to any updates from Figure 2).

We revised the Figure 5 following the reviewer’s suggestion.

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