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Biogeosciences Discussions

Interactive comment on "As different as day and night: evidence from root lifespan" *by* W. Bai et al.

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Dear editor,

We are highly appreciative of the constructive criticisms and comments by the two reviewers on our manuscript (Biogeosciences Discussion 8, C4891-C4892). We have done an extensive revision and included additional results as suggested by the reviewers. The detailed point-by-point responses to the reviewers' comments are given in the following section.

Anonymous Referee #1

The labor intensiveness in studying seasonal root dynamics is widely known among researchers. Mostly because of this labor intensiveness, there is still a void of data related to the responses of plant roots to climatic change. Studies like this one are

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clearly needed.

This study provided valuable data and found somewhat surprising results, i.e., root longevity increased when the grassland ecosystem was warmed during the day not during the night. The authors thought that the indirect effect of warming in the form of reduced soil moisture enhanced plant C allocation to roots which supported longer root lifespan. This line of thought was supported by the evidence of increased root nonstructural carbohydrates under day warming only. This conclusion implies that C allocation might be a key mechanism mediating the response of the semi-arid grassland ecosystem to climate change, especially the interplay of temperature and precipitation.

The experimental design is largely sound, particularly attractive is the use of six field replicates instead of the common approach of using three or four replicates. Multiyear dataset in this study adds strengths to their results.

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

But some discussion about inter-annual variability would be a better addition to the paper. The writing of the paper clearly needs improvements.

We have revised the manuscript by including discussion about inter-annual variability as suggested by the reviewer.

Some suggestions are given here: Page 1, The title is not as informative, use this one: Root lifespan under day and night warming?

We changed the title to “Day and night warming have different effect on root lifespan”.

Page 2, Line 4: This is only a prediction, has not been proved true or not. Suggestion: “which is predicted to occur”

We changed the sentence as suggested by the reviewer in the revised manuscript.

Line 9: the word “diurnal” here is somewhat confusing, maybe “continuous”? This applies to the entire text.

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We used the “continuous warming” throughout the manuscript as suggested by the reviewer.

Line 10-11: This sentence needs a re-write.

The sentence was re-worded as “Our results showed that day, night and continuous warming had different effect on longevity of roots born in spring, summer and autumn, and that day warming significantly prolonged the overall lifespan for the roots born in the three growing seasons pooled as a whole, while night warning had no effect on the overall lifespan in the semi-arid grassland in northern China.”

Line 14: “growing seasons of 2007-2009” is unclear. How many growing seasons? three growing seasons from 2007 to 2009? Line 16-23: Rewrite this part.

We added “three growing seasons” in the revised manuscript, and rewrite this part as suggested by the reviewer.

Line 27: change “ecosystem” to “ecosystems”

We made the change accordingly.

Page 3, Line 10: delete “of plants”

We delete “of plants” in the revised manuscript.

Line 13-14: “Day and night warming would stimulate photosynthesis and respiration, respectively.” The meaning of this sentence is unclear.

The sentence was revised to “Day warming would stimulate photosynthesis, while night warming would stimulate respiration”

Line 21-22: “the terrestrial ecosystem”? or simply “terrestrial ecosystems”?

We changed “the terrestrial ecosystem” to “terrestrial ecosystems” as suggested by the reviewer in the revised manuscript.

Anonymous Referee #2

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Similar to the other reviewer, I commend the authors for the labor intensive dataset that they have collected; I agree that the experimental design is sound; I think 'continuous warming' would be a better description of your 'diurnal warming' treatment; and I agree that more could and should be extracted from the multi-year nature of the dataset.

We are greatly appreciative of the constructive comments and suggestions on our submitted manuscript. We revised the manuscript by using the term of "continuous" warming rather than diurnal warming as suggested by the reviewer throughout the manuscript, we also followed the reviewer's suggestion to further analyze the multi-year dataset.

However, I disagree with the primary conclusion of the paper, that day warming only affected root longevity, as the seasonal 2008 analysis clearly shows that day, night, and continuous warming all have effects on this parameter at various times in the year. I do not know why the authors didn't do the same seasonal analysis on all years of data collection, or at least do a by-year or a by-season by-year analysis, rather than the cumulative 2007-2009 approach. Clearly, based on their temperature and moisture data, they had substantial variation in precipitation across years, and that 2008, was an unusual year compared the rest (wetter and cooler). A fact that could explain the sensitivity to temperature observed in this year. I suspect that the authors have glossed over some meaningful details in this dataset, and that interannual variability in precipitation is extremely important in dictating the effect of their treatments. Given the substantial seasonal variability in response to treatments, I don't understand how the authors are comfortable stating that across the whole timeframe day warming differed than night or continuous warming.

We followed the reviewer's suggestion by analyzing seasonal data of root survivorship for 2008 and 2009. As our collection of root imaging data commenced on 30 June 2007, we did not have the data for the roots initiated in spring of 2007. We added the data for roots born in the three growing seasons in 2009 and compared them with those in 2008 (see the revised Figure 2 and Table 2). Our results showed that roots born in spring

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of 2008 and 2009 exhibited similar response to day, night and continuous warming, while roots born in summer and autumn of 2008 differed from those of 2009 in terms of response to day, night and continuous warming. For example, lifespan of roots born in summer of 2008 was significantly increased by continuous warming, while lifespan for roots born in autumn of 2008 was not responsive to the three warming treatments. In contrast, lifespan for roots born in summer and autumn of 2009 was prolonged by day warming, but not nigh and continuous warming. We included these results in the revised manuscript (lines 226-240) and presented these results in new Figure 2 and Table 2. In our study, dynamics of individual root from its birth to the end of experiment were monitored using the rhizotron technique. The effect of temperature and water regimes on root growth can be reflected by root survival data. Therefore the effect of seasonal and interannual variability in precipitation and temperature on root lifespan would be minimized by using root survival data collected during the experimental period regardless of seasons and years. Therefore, our main conclusion that day warming increases root lifespan by analyzing root survival data pooled as a whole is sound and reliable. In the revised manuscript, we also discussed this point. We hope that the inclusion of the 2009 data and discussion on the seasonal and interannual variability in temperature and water status as suggested by the reviewer would strengthen our conclusion and make the paper more concise and clear.

Figure 3 is confusing. Why isn't the continuous warming treatment analyzed in the stats, if it is shown here?

The reviewer may misunderstand the rationale underlying the analyses in the Figure 3. In the analysis of data in Figure 3, two-way ANNOVAS were used to test the main effects of day and night warming and their interactions on root lifespan. Therefore, two-way ANNOVAS cannot be used to analyze the continuous warming effect. One-way ANNOVA has to be used to analyze the effect of continuous warming on root lifespan, which shows that, compared to control, continuous warming significantly prolonged root lifespan by 34$\pm$3 day (P=0.0023).

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Why show us Fig. 5 if there weren't significant differences, you've already published this data, and you don't give us enough detail to evaluate how it was collected in the methods of this manuscript?

Results in Figure 5 were used to better understand the correlations between root lifespan and BNPP/ANPP. The data shown in Figure 5 were not published in other papers. In Figure 2 of Wan et al. (2009, Ecology 90:2700-2710), the results were shown as "Changes in aboveground net primary productivity (ANPP) and belowground net primary productivity (BNPP)", and the authors also gave the ANPP and BNPP over the three growing seasons in 2006, 2007, and 2008 as APPENDIX in their Ecology paper (Ecological Archives E090-191-A1). In our submitted manuscript, we presented the mean ANPP and BNPP for the three years (2007, 2008 and 2009) in Figure 5. We detailed the protocols used for determining ANPP and BNPP in the revised manuscript as suggested by the reviewer.

I do not believe that correlation equals causation, and am therefore skeptical of the regression approach employed in the paper. I wondered what happened to temperature and moisture in these regressions, and thought that the overall presentation of the regression findings was very incomplete. We need to know what all was evaluated using this approach and what was found significant or not, what parameters were auto-correlated, etc.

The analysis of correlation has been widely used in ecological studies. There are numerous studies demonstrating that carbon allocation to root is closely related to root lifespan (Eissenstat & Yanai 1997; Farrar & Jones 2000). Therefore, we attempted to find whether the root lifespan is correlated to non-structural carbohydrate contents in roots. Our results showed that root lifespan was significantly correlated to BNPP/ANPP (Fig. 6). In addition, we also used stepwise multiple linear analyses to examine relationships of root lifespan and soil temperature, soil moisture, ANPP, BNPP, BNPP/ANPP, GEP, ER, NEP, SR, RNC, and soil inorganic N. Our results showed that 41.06% of the spatial variation in root longevity can be explained by root nonstructural

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carbohydrate content (partial r2=0.2181, P=0.0214) and soil temperature (partial r2 =0.1925, P =0.0319). In the manuscript, we made this point more clear.

Eissenstat, D.M. & Yanai, R.D. 1997. The ecology of root life span. Advances in Ecological Research, 27, 1–60.

Farrar, J.F. & Jones, D.L. 2000. The control of carbon acquisition by roots. New Phytologist, 147, 43–53.

There are many mistakes in the language of the paper (as the previous reviewer also pointed out).

We have carefully revised the manuscript by publishing and editing language.

I wondered when the root samples were taken for carbohydrate analysis. In general, I thought the methods were skimpy and certainly wouldn't allow someone to duplicate the study.

We included the methods used to collect root samples for determination of root carbohydrate in the revised manuscript as suggested by the reviewer.

Interactive comment on Biogeosciences Discuss., 8, 10459, 2011.

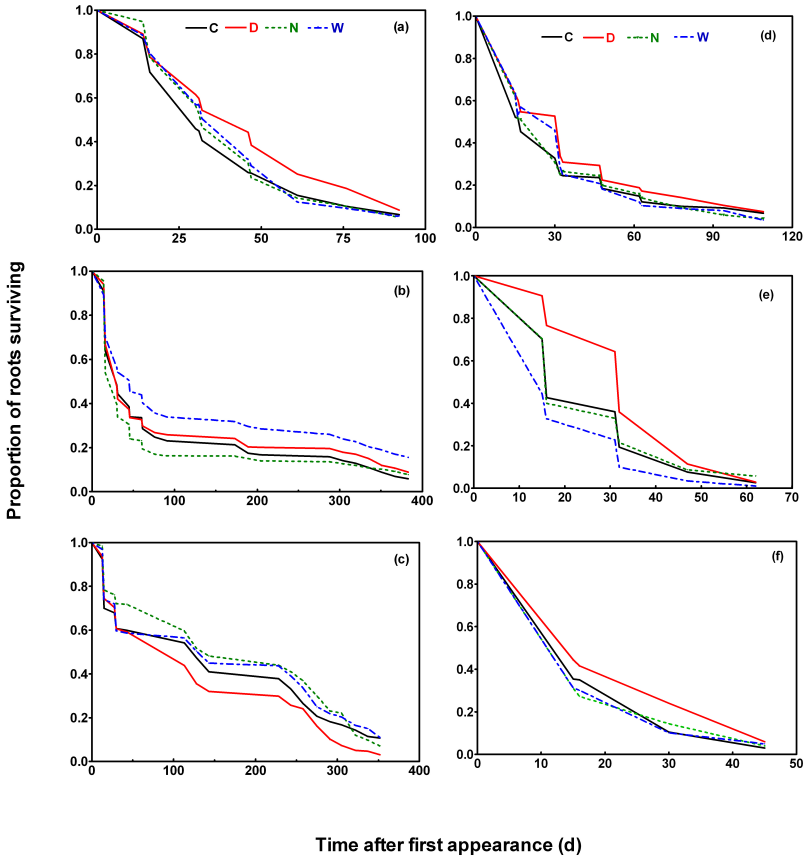

Fig. 1. Fig. 2 Survival curves of roots born in spring (a, d), summer (b, e) and autumn (c, f) in 2008 and 2009 under the control (C) and day warming (D), night warming (N) and continuous warming (W) at soil

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