Biogeosciences Discuss., 11, C7373–C7379, 2014
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Biogeosciences
Discussions
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Interactive comment on "Divergence of above- and belowground C and N pool within predominant plant species along two precipitation gradients in north China" *by* X. H. Ye et al.

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Received and published: 15 December 2014

Dear Editor, We were very pleased with the positive and constructive comments on our manuscript. Below we explain how in the main text (indicated with track changes there) we have addressed the remaining queries point by point. We hope that this has taken our manuscript up to Biogeosciences publication standard. Yours sincerely, on behalf of the coauthors, Ming Dong and Xuehua Ye

Response to referees

Anonymous Referee 1

Reported is an investigation into C and N allocation above- and belowground in three dominant plant species along two precipitation gradients in north China. The working hypothesis was that smaller proportions of aboveground biomass in drier environments would be offset by higher concentrations of N in leaves, so that the aboveground proportion of N would remain unchanged across precipitation gradients. This hypothesis was confirmed for two species. In the third species, leaf-N concentrations changed too little to offset the decrease in aboveground biomass at arid sites. I find this a very interesting, thought-provoking study. It contains new results, is well done and clearly written. The last paragraph of the Discussion section explores possible implications of the results. Here, I would like to see a few more sentences on the possible interaction between leaf N concentrations and grazing behavior. Are grazers, large mammals, but also insects, attracted by higher leaf N concentrations? If so, how would an increasing grazing pressure affect the composition of the three species studied along the precipitation gradient? Authors: thanks! It's a good idea. To raise this point we have added the following sentence to the end of the Discussion (before Conclusion): It would also be important to test whether and how the possible feedback suggested above might be influenced by possible changes in preference of livestock for different food plants as related to changing leaf nutritional value for the different species, with consequences for their abundance hierarchies at different points along the precipitation gradient.

Apart from this suggestion, I have only a few minor suggestions for improving the manuscript: Abstract, line 19: should it not "aboveground" instead of "belowground"? This would be logically consistent with the preceeding part of the sentence and also with the statement made in the last sentence on page 14184. Authors: thanks! In our investigation, S. bungeana had no significantly increasing leaf N concentration but significantly increasing aboveground biomass along precipitation gradient, leading to a decrease in the proportion of nitrogen aboveground at dry sites. It should be "aboveground", and we have changed "belowground" to "aboveground".

page 14182, lines 10, 23, 24: replace "Steam" with "Stem". Authors: thanks! We have

BGD
11, C7373–C7379, 2014

replaced “steam” with “stem”.

page 14183, line 12: replace “: : :there were a significant positive relationships: : :” with“: : :there was a significant positive relationship: : :” Authors: thanks! We have replaced “...there were a significant positive relationships....” with “...there were significant positive relationships...”.

Anonymous Referee 3

Review of Ye et al., “Divergence of above and belowground C and N pool within predominant plant species along two precipitation gradients in North China” Ye et al. investigate a potential decoupling between aboveground and belowground C and N cycling with increasing aridity. They hypothesize plants allocate a greater fraction of biomass to roots while increasing the N content of aboveground biomass in drier conditions. This could be important because grazing would have a larger impact on plants with a smaller but N-enriched aboveground component. They tested this effect by measuring above- and belowground C and N in 3 plants along 2 MAP transects in Inner Mongolia. They found the different species showed different responses to increasing aridity, with one spicies increasing belowground biomass allocation and another increasing leaf N content. I found the paper to be generally well written, and the hypothesis and potential implications were clearly stated. The data collected address an interesting and important problem and should be published in principle. However, I have some issues with the interpretation of the data, as discussed below. I therefore recommend publication of the manuscript after major revisions. General comments: -The conclusion discussed starting on line 325 (decreasing aboveground allocation to biomass that is richer in N as aridity gets more severe) is not supported by the data. Only A. ordosica had significantly decreasing aboveground biomass, and only S. grandis had significantly increasing leaf [N] with increasing aridity. None of the 3 plants showed both decreasing aboveground biomass and higher leaf [N] with aridity. Statements that the effects were “balanced” (eg line 318) to maintain a constant Authors: Actually, our results showed that there was a shift from more aboveground towards more belowground biomass al-

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location with decreasing precipitation in S. bungeana (Figure 3b). Also consistent with our expectation, there was a significant increase in leaf N concentration in the drier versus the more mesic site in S. grandis and A. ordosica, and a weaker increase in leaf N concentration in S. bungeana (r2=0.167, p=0.059) (Figure 4a). Integrating both patterns, we found that for one species, S. bungeana, there was a significant positive trend in proportion of N aboveground with precipitation (Figure 4d). To make it clearer, we changed the figures, removed the insignificant trend lines, and provided r2 and p values for the significant trend lines.

-Please address potential effects of differences in nutrient availability. Any systematic difference in N availability among the sites would also affect [N] in both leaves and roots. You would also expect greater belowground biomass allocation with greater N limitation to aid in nutrient acquisition. This possibility should be discussed in the manuscript. Authors: thanks! We agree that this is a shortcoming in our study, but we have now added some text about this in the methods, explaining why we think this issue has not had a large effect on our results: “Unfortunately, it was not logistically possible to measure soil nutrient availabilities simultaneously and repeatedly at so many points along the two gradients, given that nutrient availability is notoriously variable in time. However, we expect nutrient availabilities to have varied little over each of the transects for given species, as both Stipa species were generally sampled from unfertilized loamy soils and A. ordosica generally from unfertilized sandy soils, The remarkably flat pattern for root N content with MAP for all three species (see Results, Fig. 4b) strongly suggests that there was no correspondence between soil nutrient availability and precipitation regime, although we cannot exclude effects of nutrient availability on intra-specific variability in nutrient-related traits at finer spatial scale.”

-It appears from the figures that overall, the Authors: we don’t think so. If there is a shift in the plant community toward more drought-tolerant plants like Stipa, the relative contributions of Stipa to the plant community biomass may increase in dry sites. However, out results showed that both the relative contributions of S. bungeana in OT and of S.

BGD
11, C7373–C7379, 2014

grandis in NECT to the plant community biomass were not significantly correlated with mean annual precipitation (Figure 3A). And because our study was focused on one or two predominant plant species but not on the plant community composition, it would be difficult to extrapolate any shift in plant community based on our present results.

-The figures are cluttered with unnecessary and insignificant trend lines, complicating their interpretation. I suggest removing the insignificant lines and providing r2 and p values for the significant trends on the figure or in the caption. Authors: we have removed the insignificant trend lines, and provided r2 and p values for the significant trend lines on the figure.

Specific comments: Line 84: Increasing biomass but decreasing N allocation- you are basically hypothesizing increased C:N in the roots. Has this been observed? Roots are still living cells and have N requirements of their own. How elastic can the C:N be? Authors: this is an interesting point. Actually, in our investigation, all three plant species along the two transects had no significantly changing root N concentration and root C concentration, meaning a stable C:N in the roots along the precipitation gradient.

Line 120, 122: "Mean annual precipitation" should be abbreviated "MAP" Authors: thanks! We have changed "Mean annual precipitation" to "MAP" excepted the first time it appeared.

Line 184: I'm not familiar with the method used for C analysis, and the citation provided is to a book that's not immediately available. Please provide an additional sentence or two about the method, and consider including the calibration vs. the elemental analyzer as supplementary material with the manuscript. Authors: thanks! The method of K2Cr2O7-H2SO4 solution digestion with the oil-bath heating is a common method to determine the soil and plant carbon, and is widely used in carbon studies, such as: Zheng SX, Ren HY, Lan ZC et al., 2010. Effects of grazing on leaf traits and ecosystem functioning in Inner Mongolia grasslands: scaling from species to community. Biogeosciences, 7, 1117-1132. We have added this reference as the citation for the method.

BGD
11, C7373–C7379, 2014

Line 212: This statement is not clear and doesn't appear to be supported by the data. S. bungeana vs. MAP is the only significant relationship shown in Fig. 3B. Authors: this statement is based on the results of ANCOVA with species as an independent variable and precipitation as a covariate, which showed that the proportion of aboveground biomass increased linearly with mean annual precipitation (df=1, F=8.135, P=0.006). We have changed this sentence as "The ANCOVA results showed that the proportion of aboveground biomass increased linearly with MAP in all three species (df = 1, F = 8.135, P = 0.006);..."

Line 232: Leaf C content appears to be constant with MAP in Fig. 4. Please cite statistics showing significant relationship. Authors: thanks! We have changed figure 4, removed the insignificant trend lines, and provided r2 and p values for the significant trend lines.

Line 256: "Similar" should read "smaller" Authors: thanks. We have corrected "similar" to "weaker", which we think is even better than "smaller".

Line 295: This effect was only significant in 1 of the 3 species tested. Authors: Yes, we have make it clear by changing the sentence to "there was a shift from more aboveground towards more belowground biomass allocation with decreasing precipitation in S. bungeana (Figure 3b). Also consistent with our expectation, there was an significant increase in leaf N concentration from the drier towards the more mesic sites in S. grandis and A. ordosica, and a weaker increase in leaf N concentration in S. bungeana (r2=0.167, p=0.059) (Figure 4a). Integrating both patterns, we found that for one species, S. bungeana, there was a significant positive trend in proportion of N aboveground with precipitation (Figure 4d)."

Line 323: I don't understand where the statement "There was much more C aboveground in mesic vs. dry place" is coming from. That relationship does not appear to be significant. Authors: this statement is based on the results of ANCOVA with species as an independent variable and precipitation as a covariate, which showed that the

BGD
11, C7373–C7379, 2014

proportion of aboveground biomass increased linearly with mean annual precipitation (df=1, F=8.135, P=0.006), and there was a significant difference in elevation of these regressions among species (df = 2, F = 6.521, P = 0.003).

Figure 2: Define the criteria used for determining “similar annual and seasonal patterns of precipitation and temperature” used in the inset. Authors: thanks! We have defined it in the inset as: (with similar annual and seasonal pattern of precipitation and temperature, that is, with mean annual precipitation ranging from 160mm to 440mm, and most of MAP occurring from May through September, and with mean annual temperature from 1 to 9 âĎČ, mean temperature of the coldest month from -20 to -12 âĎČ (January), and mean temperature of the warmest month from 19 to 24 âĎČ (July)).

Short comments from JF. Liu

The paper found that a shift of C/N pool between above- and belowground was not depending on the precipitation gradient, but species-specific. I think the results will be of important significance as a case study in developing or improving related processed model(s). Authors: thanks!

Short comments from J. Liu

The study found that the effect sizes of the biomass shifts were consistent among three predominant species and the size of the shift in aboveground [N] was not, suggesting that precipitation gradients might potentially decouple the C and N pool. I think the results are very interesting and should be considered in understanding the effects of changing precipitation on ecosystems. Authors: thanks!

Interactive comment on Biogeosciences Discuss., 11, 14173, 2014.