Biogeosciences Discuss., 11, C5578–C5587, 2014
www.biogeosciences-discuss.net/11/C5578/2014/

Biogeosciences
Discussions
Open Access

Interactive comment on "Strong stoichiometric resilience after litter manipulation experiments; a case study in a Chinese grassland" *by* C. W. Xiao et al.

C. W. Xiao et al.

bertrand.guenet@lsce.ipsl.fr

Received and published: 1 October 2014

Answer to comments from the reviewer.

Comments from the reviewer were left intentionally in this document and written in roman font. Our answers are written in italics.

Anonymous Referee 2

The manuscript "strong stoichiometric resilience after litter manipulation experiments; a case study in a Chinese grassland" explores effect of increasing litter input on soil nutrients, plant growth and ecological Carbon (C) : nitrogen (N) : phosphorus (P). The

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

manuscript is well written and interesting. A better insight on the relationship between litter inputs and soil processes are indeed important for future climate change projections. However, before the manuscript can be published, I have some points which should be clarified and improved.

General comments Introduction. I agree it is much likely that with CC (climate change) we may increase biomass production in some regions. In this case, regions will receive have more rain, temperature and CO2 and thus presumably higher litter inputs. However, in other cases this might be the opposite...!!! What I missed here, is a paragraph on litter quality (which is likely to change with CC and increase in CO2 level). As we do not quite know how grassland will reaction in the future, So I recommend authors to add some lines on what we know from other CC experiments with grassland, litter quality, etc. . .

We thank the referee for this constructive comment. We modified the introduction to better present these aspects in the revised manuscript as follows: "The anticipated doubling of the atmospheric CO2 concentration within the next 100 years (Houghton et al., 2001) due to continued anthropogenic carbon emissions is generally predicted to increase net primary production of most terrestrial ecosystems. Nevertheless such effects do not scale linearly with increases in atmospheric CO2 because productivity is also partially controlled by climate. Regions with drying climates are therefore likely to present reduced net primary production in the next decades (IPCC, 2013). Although uncertainties exists in the magnitude of the changes (e.g. Campbell et al., 1991; Arnone and Körner, 1995; Gill et al., 2002), increases in net primary production are probably predominant and will simultaneously increase litter inputs to soils. Modification of atmospheric CO2, of climate and of nutrient cycling may also modify the chemical composition of the litter (Cotrufo et al., 1999). Elevated CO2 generally increases the lignin content and reduces the N concentration of plant tissues, although Norby et al., (2001) showed that this response depends on the experimental system used (open top chamber, free air CO2 enrichment, etc.)."

BGD

11, C5578–C5587, 2014

In objectives (P10490), authors highlight “priming effect” (P10490L21) this was not mention before and is neither introduced nor discussed. : : :. So up to authors to either take this subject better into account or to reword.

Priming is now defined in the new version: “We assumed that litter additions could increase nutrient release through a priming effect on decomposition rate, thereby provoking an increase in plant biomass. Priming is defined here as a modification of the soil organic matter decomposition rate induced by an input of litter and mediated by the altered activity of the microbial community. Priming effects can be negative (reduction of the decomposition rate), but are typically positive (increase of the decomposition rate) (Blagodatskaya and Kuzyakov, 2008).”

Along the same lines, priming effect, this effect depends on litter quality, soil conditions and microbial pools. Authors do not mention at all changes in soil conditions with respect to CC. I also miss some lines on how grassland store C: : :. this is mostly through root biomass than aboveground litter.

The introduction was modified following the reviewer comment as follows: “Moreover, climate change and increased atmospheric CO2 would not only affect NPP but also environmental conditions for decomposers in soils (soil moisture, temperature), inducing modification of microbial community structure and activity (Singh et al., 2010). Associated to litter additions, these effects would disturb the C cycle in soil, affecting the net ecosystem exchange particularly in grasslands where the vast majority of the C stock is stored belowground, due to their high root:shoot biomass and productivity ratios (Mokany et al., 2006).”

According to objectives authors like to asses the Relationship between litter additions and the plant biomass response (P10490L24). However, data analyses in this direction were made and reader can not determine if the relation is linear or not (see comments to possible graphs). A long the same lines I miss some correlation analyses between litter quantity (e.g. amount of nutrients added) and biomass, soil, microbs ect: : :. From

BGD

11, C5578–C5587, 2014

Bar graphs reader can not conclude on regressions, bar seem to increase with quantity added!!!

We thank the referee for this constructive comment. To check this point, we performed an ANCOVA on the response variables, using the absolute litter additions as independent variable and not as factor. This ANCOVA yielded very similar results than the ones we presented in the paper with ANOVA. Therefore, we now presented the results of the ANCOVA, which are more coherent with the scatter plots. The significant covariance also implies that there was a correlation between the observed variables and the amount of litter added. Nevertheless the correlations were only significant when including the highest litter input treatments. No effects were observed under a certain threshold; only when litter additions exceeded this threshold, plant stoichiometry was affected. Nevertheless, we modified the figures and now all the results are presented as dot plots.

MM needs several points to get clarified as reader get no information : : :.what about climatic conditions out of growing season, and how this might affect litter decomposition.

Means of temperature and precipitation are now described in the MM section with some details on the intra-annual variability: "The long-term mean annual temperature at the site is 2.1°C, with monthly mean temperatures ranging from −17.5°C in January to 18.9°C in July. Mean annual precipitation is about 380mm, with 90% of the precipitation falling in the growing season between May and October." Moreover, fig 1 was added showing the daily temperature and precipitation for the entire experimental period.

Is there an agricultural management on that site? 1000g/m2 biomass production = > 10t DM/ha this is quite high for the low fertility of the soil

No, the site is not managed. We agree that 1000g/m2 biomass production is very high. But the site receives the necessary precipitation during the growing season and these grasses have adapted to nutrient-poor conditions, by very high nutrient retransloca-

BGD

11, C5578–C5587, 2014

tion at the end of the growing season. The low C/N ratio of the soil organic matter (10) also suggests that N cycling rates are probably high enough to sustain such high productivity.

Results: Effects of litter input seem to be related to amount of input. I wonder how would look a dot-graph having the nutrient (or DM) input on the X-axis and le results Fig 2a,c on the Y. Idem plotting inorganic soil N (x-axis) with results of 3a,b and so on y-axis to see if there is any relation between quantity and effect.

All the figures are now dot-graphs.

P10490L24 non-linear relationship between litter additions and the plant biomass response.

We were not really sure what this comment meant, but because the sentence was deleted there was no more need to address it.

Discussion -I miss some discussion on the effects of litter quality (and soil climate) on decomposition (turnover time of litter ect). These topics needs to be mentioned somewhere (P10497L20ff??):...

To accommodate the referee request, we added a few sentences in the revised version to discuss the effect of litter quality on decomposition. The sentence stating the implications for our study is rather speculative, but this was made clear by explicitly stating the last sentence as an assumptio : "It must be noted that the litter used here was harvested under natural conditions. Thus, the modifications of the litter chemical composition expected under climate change are not taken into account here. Litter C:N ratio may increase in the future (Norby et al., 2001) inducing a higher microbial N demand. Microorganisms may still decrease their carbon use efficiency as assumed here or may increase the N uptake. Since the microbial N uptake in our experiment only increased for very high and unrealistic litter inputs, we assume that, at our site, microorganisms will likely modify their carbon use efficiency in response to the modification of litter C:N

BGD
11, C5578–C5587, 2014

ratio instead of competing with plants for N."

It's not that because more is available more is decomposed... Thus a real litterbag experiment would have been nice.

We fully agree with this comment; litter bag decomposition estimates would have been a nice addition. However, because the objective of the study was not to estimate the effect on litter decomposition but to better understand how modifications of litter inputs impact on the plant C:N:P ratios, the lack of a litter bag experiment is not problematic for the paper.

-As litter was inserted to 10-20cm litter incorporation is an issue as well.

We agree that it makes our experimental systems a bit different from natural, but we inserted the litter in the soil to avoid export of added litter during storms or high rainfall events, thereby better controlling the inputs. We now justified this procedure in the revised manuscript by adding the following statement: "We did not add the litter at the soil surface, but inserted it in the soil to reduce export due to wind or rain and thereby better control the amount of litter added."

-I wonder if authors ca add un paragraph on some mechanisms, future processes: : : some thoughts here: Are the applied litter amendments realistic in the future? What is the future climate in this region? (more rain, T??) How do authors expect the vegetation will change. Future variation of litter input?? What about soil C stock?

We modified the discussion following the reviewer comment: "The NPP in our study sites is expected to increase between 10 and 60% (Arora and Boer, 2014; Todd-Brown et al., 2014). Moreover, temperature is also expected to increase in China during the next decades (Piao et al., 2010), likely accelerating litter and soil organic matter decomposition and nutrient release. Future predictions about the evolution of precipitation are still highly uncertain (Piao et al., 2010)."

Conclusion Conclusion mention topics which were not tackled before neither intro nor

BGD
11, C5578–C5587, 2014

discussion: such as increase in biomass production (eg quantity) , changes in soil climatic conditions and CO2: : :. with future climate (see comments to intro). So as said before these I suggest to add some lines at the mentioned places. As also said befor, reader ca not conclude on in terms of stoichiometry and this resilience as no relation between litter inputs and plant growth etc were shown. *We thank the referee for this suggestion. These topics are now being touched upon in the revised discussion.*

Specific comments

P10488L7 what kind of litter, quality/N? Amounts? How can we scale them? Is this twice, 4, 5 times as much as expected for this steppe? Replace with " correspond to litter input increases of 15, 30, 60 and 120 % respectively"" here

We modified the abstract to clarify these issue. Please see the resubmitted version.

L13 future prediction? This is strange, not measured?

No, we scaled our inputs regarding the predictions from an Earth system model for this region. We clarified this sentence.

L14 high litter additions of what quality? I am not sure that authors will find the same with low quality+

We agree of course that litter quality matters, but in our case the same litter was used for each treatment, so we could only focus on the quantitative modifications of the litter inputs due to climate change and not on the modification of chemical composition.

P10490-L13ff to me objectives are quite similar and might be merged in on sentence Not sure that 3 objectives are needed here, might also be skipped

We simplified the definition of the objectives as follows: "The primary objectives of our study were to determine whether litter addition would increase soil inorganic N and available P and thereby enhance soil nutrient availability for plant growth and if it would affect plant growth, litter, and the C, N, P pools and the C:N:P stoichiometry of plants,

BGD
11, C5578–C5587, 2014

litter, soil and soil microbes."

L21 priming was not mention before and is not introduced: : :. So up to authors to either take this subject better into account or to reword

In the resubmitted version we defined the priming effect: We assumed that litter additions could increase nutrient release through a priming effect on decomposition rate, thereby provoking an increase in plant biomass. Priming is defined here as a modification of the soil organic matter decomposition rate induced by an input of litter and mediated by the altered activity of the microbial community. Priming effects can be negative (reduction of the decomposition rate), but are typically positive (increase of the decomposition rate) (Blagodatskaya and Kuzyakov, 2008)."

P10491 -L2ff suggest to describe the climate with some words, as compared to other places it's dry and cold. What happens in out of growing season ?

We modified the manuscript to better describe to climate of the study site: "The climate is temperate and semiarid with a dry spring and a wet summer. The long-term mean annual temperature at the site is 2.1°C, with monthly mean temperatures ranging from −17.5°C in January to 18.9°C in July. Mean annual precipitation is about 380mm, with 90% of the precipitation falling in the growing season between May and October."

L15ff the same for soil, BD in which soil layer, soil seems with very low C/N content, what about soil depth?

Soil characteristics were measured in the layer 0-30cm. The soil C:N ratio is 10 (C:N:P ratio of 57:5.7:1) which is indeed in the low range of values published (Xu et al. 2013, Global Ecology biogeography). We added this information in the revised manuscript.

L25-1000g/m2 biomass production = > 10t DM/ha this is quite High for the low fertility of the soil Is there an agricultural management on that site?

No, the site is not managed. We agree that 1000g/m2 biomass production is very high. but the site receives the necessary precipitation during the growing season and these

BGD

11, C5578–C5587, 2014

grasses have adapted to nutrient-poor conditions, by very high nutrient retranslocation at the end of the growing season. The low C/N ratio of the soil organic matter (10) also suggests that N cycling rates are probably high enough to sustain such high productivity.

P10492-L3f “fresh organic matter to the soil in the 10–20 cm soil layer, at rates. . .” what type of litter, senescent, green, ??? move L9” fresh organic matter consisted of sénescent above-ground tissues” higher equivalent to 0 (control treatment), 150, 300, 600 and 1200 g (dry mass -L7 “et primary production is assumed to increase between 10 and 60 %...” in this place?

We reorganized this section following the reviewer comments.

Fig 2a/b, 3a reduce Y-acis to max 3 (N) and 1 (P) to better see treatments effects Fig 4 may go to supplementary, results may be mentioned in the text say that belowground biomass was 6 times higher etc

We modified the graphs as suggested and now mention these results in section 3.2

P10496-L24ff suggest to reword: “ Litter amendments are substantial supply of nutrients, suggested to release nutrients during decomposition. Results show, that availability of N and P, were only modiïnËĞAËŻed for the two highest inputs treatment. Additionally, high litter addition also greatly increased soil microbial biomass C and N, indicating that soil microbial biomass does plays and activit role in nutrient transformation, conservation, and availability to plants (Wardle, 1992; Zaman et al., 1999; Tu et al., 2003). Notably, for more moderate litter additions, the observed e ï ËĞnËŸA ect on plant biomass was quite limited, suggesting that only the plant did not beneïnËĞAËŻt from these inputs. Indeed, litter addition signiïnËĞAËŻcantly increased aboveground biomass in 2009, 2010 and 2011, and belowground biomass and total biomass in 2010 and 2011 but only for the highest input level.

We modified the text following the reviewer’s suggestion.

BGD

11, C5578–C5587, 2014

P20497L19" : : :eïnËĞCËĞ cient in using nutrient resources."" Not clear

In the resubmitted version we changed this sentence into : "Since plant biomass only responded to the highest litter treatments, it suggests that, in our case, microorganisms might be more efficient than plants in using nutrient resources and plant growth might be still nutrient limited."

L26ff suggest to reword an merge with 4.2 ", those more favourable soil moisture conditions may have caused the higher soil nutrient availability via accelerated litter decomposition. Indeed, vegetation invested and allocated more biomass toward shoots than roots biomass allocation. In our study, high 5 litter addition decreased the ratio of belowground biomass to aboveground biomass, and the decrease reached a signiïnËĞAËŻcant level in 2010. Such an increase in photosyntates concentration is also explains the decline in C : N and C : P concentrations in aboveground biomass and litter upon high litter addition, but not for belowground biomass. 10498L14 " Li and Xiao (2007) also found that the soil water content, soil organic matter, " delete

We modified the text as suggested by the reviewer.

P10499LL14-17 delete this sentences has not its place here as the paper does not deals with fertilisation

We rephrase this sentence as following: "Anthropogenic modifications of the C, N and P cycles affect the natural ecological stoichiometry and causes imbalances that will have consequences for biogeochemical cycles including C-sequestration and long term structure and function of ecosystems (Lambers et al., 2010; Vitousek et al., 2010; Peñuelas et al., 2013)."

Interactive comment on Biogeosciences Discuss., 11, 10487, 2014.