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Biogeosciences Discussions

Interactive comment on "Nitrogen retention patterns and their controlling factors in an alpine meadow: implications for carbon sequestration" *by* X. L. Xu et al.

X. L. Xu et al.

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Response to the reviewers' comments

We thank the the anonymous reviewer for his rapid responses and helpful comments on our manuscript. After discussing with coauthors, we answer his responses in detail as follows:

1. *"My first concern is that the amount of nitrogen applied is enormous for an alpine meadow site. The authors write in the Mat&meth section that they applied 4.4 or 5.6 kgNhm^{-2}, this equals 440 or 560 kg N per ha. This is an N amount, which exceeds typical annual agricultural N applications by a factor of 3 to 5 and will*

disturb an alpine site and the respective element dynamics distinctly. Thus, the experiment might produce quite artificial results."

This is not problem at all. In this study we used a very low amount of N input to the ecosystem in order to undisturb the system. Here we feel that the referee might misunderstand the unit we used in the context. Actually, the unit of kg N hm^{-2} we used equals kg N ha. If the refree believe that our unit is easy to be understood by readers, we will change the unit to kg N ha.

2. *"I cannot find the link between the N-retention and the organic carbon build-up in the paper, although this is announced already in the title. There are no respective measurements. The conclusions drawn on this topic are not supported by the data provided in the manuscript."*

Indeed, we did not measure the organic carbon build-up in this studyčňbut we believe it did not affect our estimation on the organic carbon build-up derived from N deposition. The reason is that our estimation was based on the fate of deposited N in the alpine meadow. This estimation had been made by Nadelhoffer et al. (1999. Nitrogen deposition makes a minor contribution to carbon sequestration in temperate forests. Nature 398: 145-148.). Considering most of N recovered in the plant-soil system bonded together with the organic matter, we here believe that this estimation at least reflects a minimum of carbon sequestration caused by N deposition. So we suggest that the title of the paper is valid.

3. *"The authors cite a lot of useful literature (maybe in excess) especially dealing withnon-alpine sites. Unfortunately, they leave out the few papers, which already ppearedabout alpine sites and 15N applications. The most important related references wouldbe (e.g.): Körner, C.H. 1999: Alpine Plant Life: Functional plant*

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ecology of high mountain ecosystems. Springer Verlag, Berlin, Heidelberg, 2nd edition, 2003; Jaeger III, C.H., Monson, R.K., Fisk, M.C., Schmidt, S.K.: Seasonal partitioning of nitrogen by plants and soil microorganisms in an alpine ecosystem. Ecology 80, 1883-1891, 1999. Gerzabek, M.H., Haberhauer, G., Stemmer, M., Klepsch, S., Haunold, E.: Long-term behaviour of 15N in an alpine grassland ecosystem. Biogeochemistry 70, 59-69, 2004; Providoli I., Bugmann H., Siegwolf R., Buchmann N., Schleppi P.: Pathways and dynamics of 15NO3- and 15NH4+ applied in a mountain Picea abies forest and in a nearby meadow in central Switzerland. Soil Biol. Biochem. 38: 1645-1657, 2006."

Indeed, we cited a number of literatures from non-alpine sites. We using them just wanted to emphasize on the importance of investigating N retention in terrestrial ecosystems. When revising the manuscript, we will delete some of these literatures unrelated to alpine sites. Here we thank the referee very much for his listing several important papers we left out in this manuscript. We believe that these papers can improve this manuscript. We will add these papers in the new edition of the manuscript.

4. *"The authors restricted the study to a soil depth of 15 cm. After 4 years it is quite likely that part of the nitrogen can be found in deeper layers (see literature above), although this will not be a large amount."*

We agree with the referee that a part of deposited N might be retained beyond a soil depth of 15 cm over four years. This might have an influence on the total amount of N recovered in the whole system, but it also add the amount of carbon sequestrated in the system based on the fate of deposited N. We believe that it ought not to change our conclusion.

5. *"The authors write about the ammonium or nitrate retention in different N-pools. This is semantically incorrect, because the applied nitrogen will not remain in the*

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form of nitrate and ammonium after a very short time (this is underpinned by the results of the inorganic N fraction). It should read something like: retention of N applied as nitrate or ammonium; (throughout the manuscript, tables etc. at many places). "

We agree with the referee. We will change the description as suggested by the referee using retention of N applied as nitrate or ammonium throughout the manuscript.

6. *"Another semantically incorrectness is the claim that SOC can store nitrogen. SOC is soil organic carbon; nitrogen can only be stored or retained in SOM, soil organic matter! (throughout the manuscript)."*

Actually, most of nitrogen is bonded with organic carbon in soils and stored in organic matter. We will use soil organic matter instead of soil organic carbon in the new edition.

7. *"If the authors aim at a deeper insight into the short term behavior of ammonium in the soil system, they should have checked the possible ammonium fixation by swelling clay minerals (exchangeable or fixed ammonium). From other studies it is well known that a differentiation of nitrate versus ammonium behavior could be impacted by ammonium interaction with clay minerals."*

It is really a good suggestion, but it is difficult to provide an analysisi like that because we did not measure swelling clay minerals in this study.

8. *"No basic soil characteristics are provided (e.g. pH, texture, cation exchange capacity, carbonates; soil horizons)."*

We will add these basic soil characteristics in the new edition.

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9. *"Page 2647, line 23: Is the ^{15}N recovery really low, considering that app. 70% of the applied was retained. From other studies we know that the N losses are greatest during the first weeks and month."*

This belongs to language problem. Actually, I referred to the ^{15}N recovery by the inorganic N pool, not to the total ^{15}N recovery.

10. *"Page 2649, line8/9 and figure 3: There is NO correlation between SOC and ^{15}Nrecovery! A P>0.05 means NO significant correlation (you found 0.47 and 0.37, respectively). That means, you should take out all conclusions based on this result (at several places in the manuscript e.g. in 4.1, 4.2, Conclusions), you could even omit the two figures 3A and 3B."*

We agree with the referee that there is no correlation between SOC and ^{15}N recovery. We will revise our manuscript based on the suggestion above.

11. *Page 2652, lines 5 and 9: Please, take out the sentences about not shown data, which obviously are also not significant. This adds nothing to the paper.*

OK!

12. *"Page 2653, line 3-5: I cannot find a basis for the conclusion that SOC (SOM?) controls ammonium-retention. You have not checked the ammonium adsorption!"*

At present, our results cannot support the conclusion that SOM controls ammonium-retention. We will revise this description as well as the corresponding conclusion in the new edition.

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13. *"Page 2653, line 14: The authors come up with a figure of a minimal C sequestration mediated through N of 75 kg hm-2. Where does this figure come from? How was it measured (a simple calculation from the C/N ratios is certainly not possible)."*

This was estimated based on the fate of deposited N in the alpine meadow over four years. Over four years very less 15N was recovered in the inorganic pool and most of retained 15N was recovered in the plant-soil system. Because of N bonded with organic carbon in organic matters, we here assumed C/N ration of the organic matters was 15. As a result, amount of 75 kg C ha^{-1} (assuming the amount of deposited N is 10 kg per ha per year and 50% of the input is recovered in the system) was retained together with deposited N in the alpine meadows.

14. *"Page 2653, line 19-20: The last sentence of the conclusion is not really unerpinned by the results of the paper."*

This conclusion was concluded based on the calculation above. The whole area of the plateau is more than 2.5 million km^2 and alpine meadows cover 35% of the area. Based on the estimation above, we here can make an estimation that 6.6 Tg C per years is sequestrated in alpine meadows, only based on the fate of deposited N and without considering the stimulation of deposited N on plant growth. We believe that this amount is considerable on a regional basis (e.g., the Tibet Plateau), despite a very small amount on a global basis. Of course, this calculation should be presented in the context in order to make the conclusion sound.

Interactive comment on Biogeosciences Discuss., 4, 2641, 2007.