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Comment

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

**Anonymous Referee #1**

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General comments:

The present paper deals with a highly interesting topic, the behaviour of nitrogen in alpine soil systems. There are only few data based on a stable isotope approach available in literature. The authors aimed at elucidating the differences between nitrate and ammonium N-species on the retention of nitrogen in the alpine meadow. The paper provides short term data and a dataset after a four years period. Overall I found the paper quite well written and understandable, the data useful and the technical/experimental part proper performed.

However, I have some major concerns.

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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<sup>-2</sup>, 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.

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.

3) The authors cite a lot of useful literature (maybe in excess) especially dealing with non-alpine sites. Unfortunately, they leave out the few papers, which already appeared about alpine sites and 15N applications. The most important related references would be (e.g.): Körner, C.H. 1999: Alpine Plant Life: Functional plant 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 15NO<sub>3</sub><sup>-</sup> and 15NH<sub>4</sub><sup>+</sup> applied in a mountain Picea abies forest and in a nearby meadow in central Switzerland. Soil Biol. Biochem. 38: 1645-1657, 2006.

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.

#### Specific comments

1) The authors write about the ammonium or nitrate retention in different N-pools. This

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is semantically incorrect, because the applied nitrogen will not remain in the 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).

2) Another semantic 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).

3) If the authors aim at a deeper insight into the short term behaviour 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 behaviour could be impacted by ammonium interaction with clay minerals.

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

5) Page 1647, line 23: Is the 15N 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.

6) Page 2649, line 8/9 and figure 3: There is NO correlation between SOC and 15N-recovery! 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.

7) 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.

8) 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!

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

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

Technical comments:

1) page 2642, line 22, page 2643, line 2. use wide instead of wild.

2) Page 2643, line 21: not :have showed: but: showed;

3) Page 2644, line 11: better: in alpine; instead of: in studied;

4) Page 2647, line 19: significantLY

5) Page 2649, line 7: negativeLY

6) Page 2650, line 15: from our OTHER experiment;

7) Page 2651, line 4: meadows ARE compared;

8) Page 2651, line 21: might be AN important;

9) Page 2651, line 24: significantLY;

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**BGD**

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