

## ***Interactive comment on “Temporal variation in carbon and nitrogen sequestration rates in boreal soils across a variety of ecosystems” by K. L. Manies et al.***

**Anonymous Referee #1**

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### General comments

This study examined long-term and decadal carbon (C) and nitrogen (N) accumulation rates in five ecosystems, ranging from forest to grassland to fen, located along a hydrological gradient in an Alaskan floodplain. Such accumulation rate measurements are rare for some of the ecosystems and for N. The paper therefore presents novel data and addresses relevant scientific questions within the scope of Biogeosciences.

The organic soil profiles have been sampled at one site, so no real replicates, but the pro of this study is that the five ecosystems are close to each other, thus have developed under the same macro-environmental conditions (e.g. climate), allowing a comparison of the ecosystems. Unfortunately, for two ecosystems the age of the

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organic soil profile could not be determined. For these two ecosystems the age was estimated assuming they have the same age as two other ecosystems, but the ground for this assumption is not clear. A description of the position of the five ecosystems in the landscape and their dynamics (vegetation succession, shifting mosaics?) would be helpful.

The main result was that the rich fen had higher long-term (700-1400 years) C and N accumulation rates than the other ecosystems, whereas the decadal (60 years) C accumulation rates were rather similar among the five ecosystems. Possible explanations for the high accumulation rates in rich fens are well discussed, but I would like to see more discussion on the N accumulation rates.

Overall, the paper presents interesting data, which deserve publication, but more attention should be given to the dynamics of these ecosystems in the floodplain landscape and to the N accumulation rates.

### Specific comments

Title: I find temporal variation a bit misleading; it suggests that accumulation rates over multiple time periods have been compared, but the emphasis of the manuscript is on the (spatial) comparison of the five ecosystem types. Suggestion: Long-term and decadal carbon and nitrogen ...

L. 20-21: ... differences in the predominant mechanisms for nutrient cycling (for C) ... Please be more specific.

Introduction: very well written

L. 94-104: Please extend this description to include: are these ecosystems next to each other in the order given? What is their position in the floodplain landscape? What is the natural succession? How dynamic is the landscape?

L.102: Which sedge species is dominant in the “sedge” ecosystem?

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L.110: Please give an indication of the thickness (... - ... cm) of the sampled soil horizons.

L.125: Please indicate how many soil horizon subsamples were measured per profile.

L.171-173: How likely is it that the black spruce and grass ecosystems have a similar age (= started developing at the same time) as the shrub and sedge ecosystems? For grass you may be safe, as it is in between the shrub and sedge ecosystem (assuming it is positioned in-between), but how about the black spruce forest? Without information on the development of these ecosystems I find this difficult to assess.

L.224-227: Phrase more carefully, there is uncertainty for two of these ecosystems (without independent age determination).

L.230-231: If soil temperature would be the driver for C cycling in these ecosystems I would expect the lowest (thus not the highest) C accumulation rate in the rich fen as it has (by far) the highest soil temperatures, promoting decomposition of the organic material.

L.241: Here I would like to see more discussion of the N accumulation rates. What is your explanation for the high N accumulation in the rich fen? The very high accumulation rate cannot originate from atmospheric N deposition alone; there must be other sources of nitrogen. Do the mosses in the rich fen have associations with N-fixing bacteria? Is there inflow of water relatively rich in nitrogen?

L.257-258: What about the Sphagnum mosses in the rich fen? Sphagnum mosses are known to be very recalcitrant to decomposition and could therefore contribute substantially to long-term C accumulation.

L.279: Can you support this discussion with observations of charcoal in the organic soil profiles?

Table 2: Could you add a line to the legend to explain what Unsupported  $^{210}\text{Pb}$  indicates/represents?

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Table 2: A number is missing in the value for C storage in the rich fen

Table 3: Why not use the same layout as in Tables 1 and 2 with the ecosystems in columns.

Technical comments:

L.10: remove averaged

L.18-19: One decimal for the N accumulation rates is enough (the measurements were not that precise)

L.17: the highest instead of significantly higher

L.21: and instead of &

L.34: ... the net carbon balance of the boreal region?

L.114: remove a

L.191: had instead of has (results are written in past tense)

L.250: start a new paragraph with Second

L.286: C loss?

L.308: remove which appear

L.316: that that

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