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Interactive comment on "Long-term Carbon and Nitrogen Dynamics at SPRUCE Revealed through Stable Isotopes in Peat Profiles" *by* Erik A. Hobbie et al.

Anonymous Referee #1

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<General comments>

In this paper, authors try to link the observed chemical properties in peat profiles (C, N, and their isotopic composition) with current and historical biogeochemical processes over the several thousand years of peat development. Using the multiple regression analysis, they conclude that the peat profiles were controlled by the Suess effect, vegetation, hydrology, and fractionation involving C-N chemical bongs. Their approach is interesting and the information can potentially help better understand biogeochemical processes associated with peatland development.

My biggest concern is that the conclusions are drawn heavily from the results of multiple regression analysis. If I understand the Appendix 1 correctly, it appears that 238

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data points were regressed for 43 parameters. If this is correct, then there may be an overfitting problem, and some of the significance found in the analysis may be misleading. Combining plots and soil depth by functional groups (e.g., “near-legg plots” vs. “away-from-legg plots”, “modern vs. old soil horizon”, or differences in REDOX status) can reduce the number of parameters significantly.

I found the earlier part pf the paper to be somewhat difficult to follow. This was mainly because of the lack of site information, which was described later in the paper. I think that it would be more helpful to the readers, who are not familiar with this particular ecosystem, if important site characteristics were described earlier in the paper. These includes: the relative location of upland and legg; hydrology differences among upland, legg, and bog; seasonal shifts in water table (if any).

Finally, I think that the authors need to tie their findings back to the conceptual model presented in Fig. 1. by highlighting the correspondence and discrepancy between their conceptual model and their data in the discussion.

<Specific Comments>

Hummock vs. hollow is described as “topography” in some places and “micro-topography” in other. I suggest using the same word throughout the paper. Given that the authors discuss upland effects in the discussion, it is a bit confusing in some places whether they mean hummock-hollow or upland-bog.

I suggest that the authors clearly describe what was used as a reference (0 cm) soil depth. In some places, it is referenced to the hollow surface, and other places the water table.

P.4, L.19 How did fine roots identified to species? I don’t think the root C, N, and isotope data are not presented in the paper.

P. 6, L.11-12 For this statement, it would be nice to have C, N, and isotope information of roots and senesced leaves. Because roots are the major player for boreal soil C

(Clemmensen et al. 2013) and because nearly half of foliar N would be resobed during senescence, it would make more sense to use C, N, and isotope values of roots and senesced leaves than the values of live leaves, if the data are available.

P.6, L.23 “very low in %N and δ15N and high in C/N” – Showing the actual values here from the citation would be helpful.

P.8, L.17-19 It sounds that the water table in this bog is very close to the surface. I am not sure whether the presence of trees can create a large enough gradient in water potential that would affect 13C fractionation of photosynthesis. I would assume water potential gradient to be greater between the hummock and hollow than between locations near trees and away from trees.

P.9, L.2-3 Please specify which N-loss pathways are discussed here; via DON leaching or denitrification, or both? The authors mentioned earlier that DON lost from wooded upland was more 15N enriched. Is the term “sedge system” equivalent to the wooded upland? If denitirification losses were being concerned here, then higher rates in fens than bogs (P.9, L.11) could result in N lost from fens can be more 15N depleted than bogs.

Table 2. Please add the information for roots.

Fig. 1. This conceptual model and the data presented in the paper do not match in some cases. I would like to see discussions that tie their results back to this conceptual model: what are the processes responsible for the discrepancies?

Fig. 5-b. Could it be possible to add a rough sketch of study sites, overlaying the coefficient values on each plot? Adding the relative location of upland, bog, and legg on the sketch would help. I went back and forth between Fig.5-b and Fig. 2, only to find that the layout of the coefficient values do not align with the plot layout (there are different number of rows, for example).

<Technical Comments>

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P.2, L.10 “d13C of photosynthesis” – photosynthates?

P.2, L.26-27 Rephrase to explain what “topographic effects” are considered here.

P.3, L.35 “the location of future experimental plots” – future?

P.6, L.24 “seven times” – how does this frequency compare with the frequency of Sphagnum?

P.7, L.4 “breaking a C:N bond will discriminate against both 13C and 15N.” – please add citations for this statement.

Fig. 1. “methanotrophy and CO2 recapture by Sphagnum” – “recaptured”.

Fig. 3. The C/N axis does not look like natural-logged values.

Fig. 5. “plot locations are as given in Figure 1” – should be Figure 2.

References Some citations in the text are not included in the reference list.

Literature cited in this comment: Clemmensen et al. (2013) Science, 339:1615

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