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Biogeosciences Discussions

Interactive comment on "Soils from cold and snowy temperate deciduous forests release more nitrogen and phosphorus after soil freeze-thaw cycles than soils from warmer, snow-poor conditions" *by* Juergen Kreyling et al.

Anonymous Referee #1

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General comment

This is a well written manuscript on a timely topic, which studies the effect of freeze thaw cycles on N and P release between snow-poorer warmer and snow-richer colder forest soils. The manuscript is very well and concisely written, clearly structured, and provides clear aims, hypotheses, and approaches. Especially the statistical analysis of the data is very strong, with a transparent use and analysis of the data. The major shortcoming of the study is lack of crucial soil data without whose, the outcome, discussion and conclusion remain speculative.

1. It remains unclear from which soil depth the samples had been taken and what was the criterion of the sampling. Soil temperatures in the mineral soil are known to be well buffered against air temperatures and hence it even remains unclear to which the soils studied have indeed historically experienced FTCs. Although it is described that soil temperatures had been recorded, the data are not shown except minimal winter temperatures.

2. In addition, data about inherent soil properties are lacking. For instance, soil organic matter contents are not given. Soil organic matter is a key soil parameter driving soil microbial communities and the release of nutrients and thus of nutrients released upon lysis of microbial cells. As SOM greatly varies with climate (and which soil depth) it seems likely that it is a key co-variable which could drive the observed responses and as such it should be reported, incorporated into the statistical model and/or discussed.

3. Moreover, the amount of nutrients released should be normed to the amount of nutrients present in the sample. It should be made clear which drivers are/could be responsible for the observed nutrient concentrations: for example inherent nutrient content, C/nutrient ratios that drive the net release of nutrients, or historical FTCs. The concepts and data on other drivers should be considered in the data analysis and/or ruled out in the discussion.

4. Details from the laboratory experiment are lacking or not clear. For example, was the soil moisture kept constant during the incubation, what was the reasoning for the different incubation times or what were the equidistant temperature changes?

Other comments

1. Provide information on effect sizes (increase of nutrient mobilization due to FTC treatments as compared to control). So far, the effect size is only shortly discussed for the most extreme site with the most extreme treatments. And, as far as I understood, for the models the absolute concentrations are used which, however, might be biased by inherent differences. What is the rationale behind the use of absolute concentrations?

2. The reading would be facilitated to have the graphs (Fig. 1-3) at the same spot. This would allow to compare the patterns for the three different nutrients. And in general, use the same perspectives for the graphs and in the same order for all three figures.

3. Visualization of measured analytical data is missing. The graphs from the models are great, but showing the measured data would helpful additional information for many scientists working in this field (or at least provide the information in the supplementary material).

Details/Specific comments:

1. Line 43: “more than”?

2. Line 45: Nutrient limited: Could you be a bit more precise: Which nutrients, is there co-limitation and is it true for all cold-temperate deciduous forests?

3. Line 60: “colder temperatures” than?

4. Line 61: What about cell lysis because of drying-rewetting cycles?

5. Line 62: freeze thaw cycle: abbreviation already introduced

6. Line 65: physiological re-adaptation to thawing conditions may lead to microbial carbon and nutrient release – not sure what this means

7. Line 89: would be interesting to directly give the amount of N deposition in Central Europe as comparison

8. Line 94: P nutrition is recently decreasing: Recently it was researched, but I think the problem is not recent. It is more likely the recent change in C:N:P stoichiometry that can push P to be a limiting factor

9. There are also attempts to analyse biome patterns of FTC effects (e.g. meta-analysis document higher susceptibility of temperate ecosystem than arctic and high latitude; Gao et al., 2017 Global Change Biology)

10. Line 98: FTC has been introduced before

11. Provide information on average snow heights or some measure of FTC frequency available. Mean winter temperature are not necessarily a good indicator for FTC.

12. Line 127: soil sub-samples? Could you be more precise? From which horizon(s) where the soils taken? What was the criterion for soil sampling? This is a very crucial information for nutrient dynamics!

13. Line 135: Information especially about organic matter content but as well of further soil parameters like microbial biomass would be crucial to draw conclusions about the impact of FTC cycles on nutrient mobilization!

14. Line 140: Table 2: Phosphate-ion is three times negatively charged, Column soil moisture (SM): change to English punctuation

15. Line 146: to clarify: equidistantly between -1.2 and -12°C : deltaT= 10.8°C / 7 = 1.542°C T intervals?

16. Line 160: ‘Temperature directly at the soil samples’. Please provide details. Same depth, same location? How many FTCs have occurred? Why are the logged data not shown (at least in supplemental information)?

17. Line 163: Just to clarify: samples with 1 FTC were extracted after one day, samples with 5 FTC after 5 days, controls after 7 days? What is the rational behind the immediate sample extraction after the treatment has finished in comparison to the extraction for all samples after 8 days – at the end of all treatments and with the same incubation time?

18. Line 178: molybdenum blue

19. Line 180: Determination limit: Do you mean detection limit?

20. Line 179-180: The determination limit is 0.05 umol L-1 vs. The determination limit was slightly higher with 0.1 umol L-1? Sentences are unclear

21. Line 235: Quality of graphs – resolution, axis labels overlap, axis numbers difficult to read

22. Line 235: Graphs: NO3 data: is this the additional release of NO3 compared to control or just the total NO3 release? Please clarify – and I would suggest to use the numbers normed to the control data

23. Line 270: Table 4: Would be nice to have the models numbered as done in table 3

24. Line 286: copy-paste error? Should probably be phosphate instead of ammonium

25. Line 291: coldest site or sites?

26. Line 316: How do we know its short-term? Like a flush? If there was only one measurement after the treatment?

27. Line 322: activating N and P? wording

28. Line 322: (1) minimum temperatures of -7 to -11°C were only reached for half of the treatments, but increase of nutrient concentration seems to increase linearly with increase FTC magnitude... which is also shown with the models with only magnitude as single factor where the linear model was the best. Would it not be expected to see a stronger increase of nutrient release when reaching the -7°C if this explanation (1) is right?

29. Line 358: 'Contrary, our coldest sites rarely experienced serious FTC in the past'. This seems likely but are there any data supporting this statement? As soil had been sampled in well-buffered subsoils, the FTC frequency and magnitude is open

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