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## ***Interactive comment on “Recurrent winter warming pulses enhance nitrogen cycling and soil biotic activity in temperate heathland and grassland mesocosms” by J. Schuerings et al.***

### **Anonymous Referee #1**

Received and published: 10 June 2014

**General comments** The manuscript describes a study on the impact of warming pulses during winter on N cycling in middle Europe. The results are interesting but the introduction and discussion are very superficial and do not indicate how this study relates to the existing literature and how it extends/broadens the current knowledge on this subject. In addition, considering that the measurements included various variables that could have affect N cycling (soil biotic activity, plant species richness, biomass, diversity, plant identity) no attempt was made to compare the relative role of each of these factors or the potential interaction between them. Finally, the induced temperature regimes suggest that the warming was a more likely factor behind the N responses as there were hardly any differences in freezing temperatures between treatments. The

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intensity of the warming pulses and their realism, are however not discussed in the manuscript.

Specific comments Lines 11-14: line 11 suggests that the current knowledge on N uptake is fully addressed. However the two following lines indicate that this is far from clear. Please rephrase these lines. Further there is no explanation on the mechanisms of winter N uptake. Which processes are involved; what is their activity during winter compared to summer and how are these processes affected by temperature changes? Line 16: in the previous paragraph the focus is on soil temperatures why the shift to air temperature? Lines 16-18 why is there a contradiction here 'nevertheless' ? Line 18 as frequently as what? The whole paragraph starting at line 16 is incoherent and lacks logical steps between statements and conclusions. Line 5 (7800) please indicate as to how/in what way grasses are more responsive than dwarf shrubs and how does this reflect on the contrasting responses observed in the two cited studies? Thereafter, these differences in responsiveness need to be linked to N cycling which is the main theme of this paper. Is the positive/negative responsiveness of species/groups directly linked to the plants ability to take up N during winter? Lines 11-12 why would increased N affect the increased risk of frost damage? One important article that needs to be cited here: Macgillivray CW, Grime JP, Band SR, Booth RE, Campbell B, Hendry GAF, et al. Testing predictions of the resistance and resilience of vegetation subjected to extreme events *Funct Ecol.* 1995;9(4):640-9.

Line 15 where does the extracellular enzyme activity suddenly come from? This should be properly introduced in the previous introduction paragraphs. I don't understand the logic behind hypothesis 2. If a site is located in a region with typically colder winter temperatures why would you then expect it to respond stronger to changes in winter temperature than a site that has milder winter temperatures? I would expect species to adapt to the severity of the winter climate. Lines 23-24 where do the grassland and heathland communities suddenly come from? These should be introduced in the previous introduction paragraphs.

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Methods: Line 8 are you sure that the botanical gardens of Bayreuth are only 11° N of the equator? Line 12 how were the heating cables placed in relation to the soil? Did the heating cables in any way interfere with the growth of the plants? Were dummy heating cables also added to the ambient plots (similar to the lamps)? Why were the heating cables inserted and was there also a treatment with lamps but without soil heating cables? Were the measured soil temperature increases (nearly reaching 10 C) in coherence with observed/expected changes in soil climate? Line 15 how many pulses were given and why that number? Line 21 why calculate an abstract mathematical value (CV) which is much harder to comprehend, for temperature when you have the actual temperature data? Simply state the temperature of one treatment to that of the other or calculate a relevant measure for temperature variability i.e., freeze-thaw cycling, occurrence of deeper frost etc. Line 23 so there was a snow camera for each of the mesocosm blocks? Response parameters: Why was the bait lamina method used here? IT has previously been shown that his method only works reasonably well for earthworms; Gestel CAM, Kruidenier M, Berg MP. Suitability of wheat straw decomposition, cotton strip degradation and bait-lamina feeding tests to determine soil invertebrate activity. *Biology and Fertility of Soils*. 2003;37(2):115-23.

'The stopping buffer also raises the pH of the solution, because fluorescence is strongest in the alkaline pH range (pH > 9).' Surely the stopping buffer does not raise the pH because fluorescence is higher at pH over 9. A logical step/explanation is missing here.

Why were the enzyme essays done at 21C? This is not a typical soil temperature for central Germany and certainly not typical for winter conditions. . . -So how representative is this analyses for the actual activity in the field?

Line 20 here it is stated that the soil temperature became more extreme. The term 'extreme' needs a better definition. Further, on line 23 it is stated that the minimum temperature was nearly identical (differences of 0.2 C) between treatments this does not suggest a more 'extreme' soil temperature environment. There were no changes

in freeze-thaw cycles and the 'much colder temperatures' were only 2 C lower than the control plots in the colder site.

Discussion line 19: see earlier comments on the severity of the treatments. The treatments need to be viewed in relation to the natural variation that exists across years. Is -2 C the coldest ever measured at the 'cold' site?

Lines 23-25 true statement but how does this reflect to your findings? The results indicate that there were no differences in FTC between treatments suggesting that for your study sites FTC were not relevant. How does this relate to the results/conclusion of the cited articles? Could the strong responses measured in this study have anything to do with the soil temperatures reaching nearly 10 C? Page 7809line 5 you already mentioned the role of FTC on N cycling. Lines 5-10 this discussion needs to be broadened; the results indicate no differences between treatments in FTC but increased cycling of N. Therefore, this suggests that FTC did not affect N cycling in this study, this needs to be reflected to the findings of others. Further, how does the -4 C stand out from longer term records? Why would the occurrence of a decreased minimum (which may only have occurred once ; this is not made clear) by 2 C affect N cycling so much? What actually stand out from figure 1 is the much higher soil temperatures that were induced during winter and not so much the colder (freezing) temperatures following these events. This needs to be addressed in the discussion.

Line 15 how does the local climate affect N cycling?

PRS probes have a passive exchange of anions and cations with their environment meaning that at all times the PRS is taking up and releasing ions. The extracted NH<sub>4</sub> and NO<sub>3</sub> from the PRS probes therefore reflect the availability of these anions and cations right before sampling and do not incorporate what has happened during winter. (PRS probes do not capture and hold onto NH<sub>4</sub> and NO<sub>3</sub> indefinitely)

Lines 20- end of paragraph, this is mainly a summary of the results again without clear explanations of how and why differences were observed and there is no citation to any

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other literature in this paragraph.

Line 25 (7810) I have not read about any biomass measures in the results or methods section. . . This data needs to be incorporated in the results section or the text should be removed from the discussion on this subject.

What is the difference between chronic and continuous warming?

Conclusions: It is true that this study showed N cycling to respond to the variable temperatures induced by the treatments but I have some doubts on whether this is in response to the minimal changes in freezing temperatures; instead the much higher soil temperatures may have played a stronger role here. The difference in  $^{15}\text{N}$  uptake between sites does not follow logically from increased frost damage. There was no apparent larger frost apart from a one-off lower freezing temperature of just 2 C which I would expect to be part of the climatic variation. In the conclusion the authors also allude to frost damage but there was not data on shoot biomass of damage measured presented in the results; this conclusion is therefore not justified.

Figure 1 considering that heating lamps and cables were present how come the temperature increases were so variable? In addition, some of the soil temperature treatments reached nearly 10C this is somewhat worrying considering that all this heat had to come from above and may have seriously overheated the aboveground plant parts.

Figure 2 please indicate which bars significantly differ from each other in the figures. Figure 4 bc suggest reducing the scale of the y-axis to improve readability.

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Interactive comment on Biogeosciences Discuss., 11, 7797, 2014.

**BGD**

11, C2323–C2327, 2014

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