Biogeosciences Discuss.,
doi:10.5194/bg-2016-91-AC2, 2016


# *Interactive comment on* "Wildfire effects on ecosystem nitrogen cycling in a Chinese boreal larch forest, revealed by $^{15}$N natural abundance" *by* Weili Liu et al.

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Received and published: 27 June 2016

We appreciate the reviewer 2's professional comments which helped us to improve our manuscript. According to the comments we modified the manuscript as detailed below.

Reviewer 2's comments: The "mechanisms" that explain these observations are derived from patterns within the observations, but there are two problems associated with this extrapolation: 1) I was concerned by the fact that the mineralization results are compared to the TIN results, despite the fact that they were taken in different seasons. Specifically, the TIN samples were collected before (June) the wettest part of the year (June to August; Line 107), whereas the N mineralization samples were collected after the wet season (Autumn, but not specified). Though it is well known that the size and



direction of N pools and fluxes can change seasonally, these data are compared to each other as though they represent the same N. For example, the authors posit that the "high soil NH4+ pools did not lead to an elevated net nitrification rate" (Line 274), but the NH4+ pool and the net nitrification rate were collected months apart and likely had little bearing on each other. These two time points should not be compared this way.

→Authors' response: First of all, there was a typo in our previous version. The N mineralization samples were collected in early August, not early Autumn. Still, we accepted referee #2's comment regarding the improper comparison of TIN and N mineralization values that were measured at two different time points. In fact, a similar concern was also raised by reviewer 1. In this revision, we provided new data about inorganic nitrogen concentrations in August to ensure the comparison of these two variables were derived from the samples collected at the same time (Figs 2D-F). We showed the ammonification rate of the organic soil in the burned area was higher than that in the unburned area. To the contrary, the ammonium concentration was significantly lower than that in the unburned area.

Reviewer 2's comments: "2) As a result of the previous comment, the "mechanisms" that could explain these patterns of N cycling are difficult to establish, at best. The authors state that "a large amount of NH4+ was lost through volatilization" (Lines 276-277). However, there is no empirical evidence for this, and no way in which to rule out other mechanisms that explain differences in 15N isotopic signatures between the sites, such as denitrification or combustion (the authors addressed these, but emphasized volatilization as the proximate mechanism controlling 15N)."

→Authors' response: Reviewer 1 also raised this issue. Please see our response to Reviewer 1's general comment.

Reviewer 2's comments: "Throughout, from the title through the discussion, there is a strong emphasis placed on the revelation that $\delta$15N represented an "open" N cycle.

For example, in the introduction, it is stated that "$\delta$15N could provide us a promising and comprehensive tool to detect the effect of wildfire on N cycling" (Lines 57-58). This makes it sound like establishing this is an objective of the paper, but this is a well-established use of these measurements (see Martinelli et al. 1999). By contrast, the important result related to the stated objectives would seem to be that fire leaves an open N cycle for several years. Likely, this problem could be addressed by changing verbiage."

→Authors' response: we have accepted referee #2's comments and changed the wording to "In fact, although the responses of available N concentration and N mineralization to wildfire could vary by time and space, we can expect higher values of $\delta$15N in plant and soil as a legacy of longer or short term opening in the N cycles when available N supply exceeds demand, resulting in an increase in N loss. Therefore, $\delta$15N could provide us a promising and comprehensive tool to detect the legacy effect of wildfire on N cycling openness years after the fire disturbance has occurred."

Reviewer 2's comments: "There was a paucity of information about the fire: it was described as severe (line 118), but little other information was provided than unpublished results, not explained in the methods, that there was a tenfold loss of aboveground biomass (Lines 275-276). I wonder why the authors would expect to see a recovery of the N cycle given such substantial fire-related effects persist? This was not clearly articulated in the manuscript- what was the underlying rationale for this work, other than the lack of data on N cycling from Chinese larch forest?"

→Authors' response: We added more information about the fire as the following. The historical fire regime in this region is described as frequent, surface fires mixed with infrequent, stand-replacing crown fires, with fire-free interval ranged from 30 to 120 years (Xu et al., 1997; Liu et al., 2012). However, climate change, forest management and human activities have altered fire regimes in this region (Jackson et al., 1997; Wang et al., 2007). Although the dominant tree species Dahurian larch is regarded as a fire-tolerant species with thick bark near the stem bottom, its post-fire mortality



rate is still high, mainly due to a horizontal shallow-distributed root system (Fang et al., 2015; Vijayakumar et al., 2016). A stand-replacing wildfireïijŇwhich was ignited by lighting, burned 600 ha of Huzhong National Natural Reserve on June 26th, 2010. This fire provided an ideal opportunity to study the effects of fire on soil N dynamics in this ecosystem." As to the post-fire recovery patterns of the N cycle, extensive meta-analysis and literature review studies have reached a consensus that N availability immediately after fire would be elevated, followed by a rapid decline within the first few years (Wan et al., 2001; Smithwick et al., 2005; Wang et al., 2014). Such short-term N cycling responses to wildfire have been widely documented in grassland and temperate forest ecosystems that are dominated by low-severity wildfires. For the forest ecosystems dominated by high-severity fires, the effects of wildfire on N cycling remain controversial. Some studies reported N availability would return to unburned level after several years since the wildfires (Turner et al., 2007; Koyama et al., 2010), while others documented the persistence of elevated N availability for several decades (Deluca et al., 2002; Kurth et al., 2014). Notably, all of these studies occurred in US and North European forests that experienced stand-replacing fires. In contrast, there is a scarcity of such studies in Eurasian boreal forest. Our research group has previously investigated two fires burned in the Chinese boreal forest and found that N availability in one-year-after-burn stands was significantly higher than unburned stands, but such elevated N availability was not detected in 11-yr-after-burn stands (Kong et al., 2015). In light of literature and our previous work, we hypothesize that the inorganic nitrogen concentrations and N mineralization rates in the burned area would be similar with the unburned area.

Reviewer 2's comments: "I was also surprised that there was no mention of the role of cation exchange capacity in N cycling. While fluxes of N were affected by fire in the litter, N pools were affected in the soil. This likely represents the simple fact that a changed physical environment, combined with a reduction in plant uptake, means greater microbial processing of N in the organic layer and greater sorption of N in the mineral soil. This wasn't clearly articulated despite the fact that several lines were dedicated to changes in temperature (Lines 239-244)."

→Authors' response: Thanks for the excellent suggestion. In this revision, we discussed how changes of biotic and environmental conditions could contribute to the increase of N mineralization. We pointed out that the increased cation exchange capacity and pH resulted from ash deposition, and the increased temperature resulted from decreased thickness of organic layer would promote microbe activities, which could result in higher mineralization in the field. The resulting increased N mineralization in the organic soil, coupled with reduction of plant uptake, could further lead to greater sorption of N in the mineral soil. We made the following changes: Post-fire abiotic environments such as increased soil pH resulted from increased base cation availability and temperature (Table 1) tend to be more suitable for microbial activities (Smithwick et al., 2005). Increased temperature might have played a key role in N transformation (Klopatek et al.,1990) because decomposition rates may increase by 50% - 100% when soil temperatures increase 5 oC – 10 oC (Richter et al., 2000).

Reviewer 2's comments: Some specific comments: There were a number of typos and awkward phrases that would need to be cleared up before publication (for example: "winder" instead of winter (Line 106), "sever" instead of severe (Line 118), "colorimely" instead of colorimetrically (Line 146), "filtrated" instead of filtered (Line 131), "burned polts" instead of burned plots (Table 2) – not a complete list).

→Authors' response: We appreciate that the referee #2 pointed out the problems in English presentation and have thoroughly checked our spelling.

Reviewer 2's comments: There are better citations for studies suggesting N limits high latitude terrestrial ecosystems than Popova et al. 2013 and Stark & Hart 1997 (Lines 34-35). Consider Vitousek & Howarth 1991, Lebauer and Treseder 2008, Elser et al. 2007, and Harpole et al. 2011).

→Authors' response: we have accepted referee #2's suggestion and used the citations of "(Elser et al. 2007, Harpole et al. 2011; Lebauer and Treseder, 2008; Vitousek and



Howarth 1991)" to replace the citations of "(Popova et al., 2013; Stark and Hart, 1997)".

Reviewer 2's comments: How is Figure 3 different from Figure 4? Similarly, how are the values provided in the paragraph beginning on Line 202 different from the values described in the paragraph beginning on Line 211? Both involve foliar $\delta$15N, for example. Not clear.

→Authors' response: We agree these two figures seemed redundant. Therefore, we kept Figure 4 with more detailed information of N pool for different plant tissue and soil profiles, and we presented the data of Figure 3 as the Appendix 1.

Reviewer 2's comments: "How was the branch, moss and fine root 15N relevant to the objectives? Seems like these data, especially the moss, are ancillary and it was not clearly stated that there was a goal to observe vertical profiles of $\delta$15N signatures from tree top to 30 cm mineral soil."

→Authors' response: Figure 4 showed the vertical profiles of $\delta$15N signatures from tree top to 30 cm mineral soil. We found that wildfire had a more significant effect on plant than soil and the effect of wildfire on soil would decrease with the soil depth. The Figure 4 also showed the litter return might be a potential mechanism for the 15N enrichment in organic soil.

Reviewer 2's comments: "Figure 1 didn't come out very well, and wasn't very helpful. The caption makes it sound like the unburned area is in the burned area: "Unburned area is chosen in the nearby burned area as control." →Authors' response: We appreciate that the referee #2 kindly pointed out the problems in Figure caption. We changed the caption to "Research locations in the Huzhong Natural Reserve (HNR), China. A large wildfire burned almost 600 ha mature larch forest within the HNR in the summer of 2010. The red boundary represents the burned area. The black triangles represent burned plots, the yellow circles represent unburned plots which were established in the unburned area as control." We also added the sketch of the Huzhong Natural Reserve (HNR) and the locations of 2010 burned area in Figure 1.

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