

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

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We appreciate referee #1's positive assessment of our manuscript and the constructive comments. Replies to the raised points are provided below:

Reviewer 1's general comments: "General comments: The pattern that  $^{15}\text{N}$  values of plant and soil increase after wildfire and return to the pre-fire values has widely been observed in many terrestrial ecosystems (Szpak, 2014). This study provides new data on the isotopic pattern from a boreal forest in China. In this manuscript, the authors conclude that ammonium volatilization is the main driver of the increase of  $^{15}\text{N}$  (Line28, Lines 282-284). Although I also think ammonium volatilization is one of possible explanations about the increase of  $^{15}\text{N}$ , there seems not enough evidence supporting this

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conclusion. The authors argued that difference in ammonium and nitrate pools and N mineralization rates between burned and unburned sites could be due to ammonium volatilization. However, the present results were based on only one-time estimation, and thus they seem not convincing enough to suggest the occurrence of greater ammonium volatilization in the burned sites. As the authors discussed, N loss due to nitrate leaching could also have caused the enrichment in soil  $^{15}\text{N}$ . Further, greater dependence of plants on deeper soil N, or less dependence on N derived from mycorrhizal fungi in the burned sites might also have increased the  $^{15}\text{N}$ . These  $^{15}\text{N}$ -enrichment mechanisms appear to be equally plausible at this stage. To explore the enrichment mechanisms, it would be necessary to investigate N budget of the studied forests,  $^{15}\text{N}$  values of DIN and TN, root distribution, and infection rates of mycorrhizal fungi in the roots. Unfortunately, however, these data were not presented in this manuscript. As such, the authors would need to modify Discussion section to discuss these explanations more carefully about the increase of  $^{15}\text{N}$ ."

→Authors' response: Thanks for your constructive comments and helpful suggestions. We acknowledged that there are multiple mechanisms (e.g.,  $\text{NH}_3$  volatilization, combustion, litter return, denitrification) that can contribute to the observed  $^{15}\text{N}$  enrichment in the soil. We no longer speculate that  $\text{NH}_3$  volatilization is the main driver of the increase of  $^{15}\text{N}$ . Instead, we provided a suite of mechanisms that might be equally plausible in explaining this observed pattern. Please see Lines 27-28, Lines 311-313 and Lines 372-374 for details on how we revised the discussion and conclusion to reflect this point. To address the reviewer's concern regarding different time points when comparing ammonification rate and ammonium concentration. 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 (Fig. 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. Such reduction of ammonium could be very likely due to  $\text{NH}_3$  volatilization, although several other mechanisms such as sur-

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face run-off and filtration to mineral soil might also contribute to this observed pattern. We have revised the manuscript accordingly to illustrate this point. Please turn to the attached copy of the revised ms for details in Lines 215-220 and Lines 302-313.

Reviewer 1's comments: The discussion about openness of ecosystem N cycle (Line 325) could be made in conjunction with the earlier paragraphs about ammonium volatilization and nitrate leaching, because these two processes are the main N loss pathways when N cycle become open.

→Authors' response: We accepted the referee #1's comments and modified the discussion section. Please turn to the attached copy of the revised ms for details in Lines 311-313 and Lines 328-335 in 4.2.

Reviewer 1's comments: The authors used average  $^{15}\text{N}$  values of all plant species for the comparison between burned and unburned sites (Table 2). However, this comparison would need to be performed for each plant species, because different plant species have distinct niches for N acquisition, which are reflected in variation in  $^{15}\text{N}$  among plant species (Table 2).

→Authors' response: we completely agree with the referee #1 in that "different plant species have distinct niches for N acquisition, which are reflected in variation in  $^{15}\text{N}$  among plant species". We not only used Figure 4 to show average  $^{15}\text{N}$  value of all plant species in burned area was significantly higher than that in the unburned area, but also used Table 2 to show the differences in the foliar  $\delta^{15}\text{N}$  in burned and unburned area for each specific plant species. Some plant species, such as *Ledum*, *Vaccinium* and *Deyeuxia*, can be observed in both burned and unburned area, whereas their foliar  $\delta^{15}\text{N}$  in burned area were significantly higher than those in the unburned area. Therefore, Table 2 revealed that the differences of foliar  $\delta^{15}\text{N}$  in burned and unburned area were resulted from differences in fire history.

Reviewer 1's comments: Minor comments: 1) L79: A reference would be needed. 2) L128: Please explain in more details how the soil temperature was measured. 3) L134:

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Please add more explanations about the sampling (e.g., tree species). 4) L136: Please describe the species name of the moss. 5) L170: total nitrogen (TN), total carbon (TC) 6) L181: It would be better to avoid the expression "XX was reduced (or increased) after fire" throughout this manuscript, because this study did not examine the pre- and post-fire effects in the same sites, but compared the soil properties between burned and unburned sites. 7) L259: Please add more explanation about "potential mineral N rates". 8) L281: References would be needed for the effect of soil temperature on  $\text{NH}_3$  volatilization. 9) L289-293: Please clarify this sentence.

→Authors' response: We thank the referee #1 for the thorough technical comments. These modifications are: 1) – We added the reference (Xu et al., 1997) in the L84; 2) – We added such information of soil temperature measure as the following "We also recorded the temperature of organic layer by soil thermometer at the soil depth of 5 cm (whenever applicable). The soil temperature was measured between 10am and 4pm. To account for the inherent hourly and daily temperature variations, we also measured soil temperatures at two fixed places at the hourly basis and used them as the baseline temperature data to correct such sources of uncertainty. The corrected values would be used to compare the difference in mean soil temperature between burned and unburned areas". 3) – We added the information of tree species both in burned and unburned area in as following: "In the unburned area, the dominant overstory species is *Larix gmelinii*, and the dominant understory species include *Vaccinium vitis-idaea*, *Ledum palustre*, *Rhododendron dauricum*, and *Pinus pumila*. In the burned area, the dominant species include seedlings of *Larix gmelinii* and some shrubs and herbs, such as *Vaccinium vitis-idaea*, *Ledum palustre*, *Carex schmidtii* and *Rubus sachalinensis*". 4) – We added the species name of moss as following: Different moss species were observed in unburned and burned area, *Hypnum* spp. was observed in the unburned area, whereas *Polytrichum piliferum* was the common moss species in the burned area. 5) – We added the "total nitrogen and total carbon" in L197; 6) – We accepted the referee #1's suggestion and replaced "XX was reduced (or increased) after fire" with the expression of "XX was higher (or lower) in burned area than that in unburned

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area” throughout the manuscript; 7) – We added the information about “potential mineral N rates” by “using the 14-day anaerobic incubation procedure”; 8) – We added the reference (Nelson and Conrad, 1982) about the effect of soil temperature on NH<sub>3</sub> volatilization; 9) – We changed the sentence to “On the other hand, the lack of increase in net nitrification in the burned organic soil resulted from 7-day laboratory incubation might be due to an enhanced denitrification, which is associated with strong fractionation against <sup>15</sup>N and higher gaseous losses of <sup>15</sup>N-depleted N<sub>2</sub> or N<sub>2</sub>O, remaining soil NO<sub>3</sub><sup>-</sup> to be enriched in <sup>15</sup>N (Hobbie and Ouimette, 2009; Robinson, 2001)”

Please also note the supplement to this comment:

<http://www.biogeosciences-discuss.net/bg-2016-91/bg-2016-91-AC1-supplement.pdf>

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