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Interactive comment on "Divergence of dominant factors on soil microbial communities and functions in forest ecosystems along a climatic gradient" *by* Zhiwei Xu et al.

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Reviewer #1: Interactive comment on "Divergence of dominant factors on soil microbial communities and functions in forest ecosystems along a climatic gradient" by Zhiwei Xu et al. Anonymous Referee #1 Received and published: 28 September 2017 Divergence of dominant factors on soil microbial communities and functions in forest ecosystems along a climatic gradient is a investigation paper. Authors chose 12 forests along three climate zones to investigate the variation of soil activities and microbe structures among these forests along three climate zones. The results showed that soil enzyme activities and microbial PLFAs differed with forest types along climatic zones. Both climate and forest type had significant effects on soil enzyme activities and microbial communities. Litter nutrients made an important effect to variations in the soil microbial communities and enzyme activities in temperate zones, while soil micro-climate and nutrients were the main effect factors on the soil microbial community structure and enzymatic activities in warm temperate and subtropical zones. The C1 BGD Interactive comment Printer-friendly version Discussion paper has valuable to be published in this journal. However, the following points should be considered to revise.

(1) Abstract: line 44-45 "Our results indicate that the main controls on soil microbes and functions vary across forest ecosystems in different climatic zones, and that the effects of soil moisture content, soil temperature, and the soil N/P ratio were considerable." was the results, not indications. Instead, please give a general summery about reasons of the variation.

AN: we have improved this part as "Our results showed that the main controls on soil microbes and functions vary in different climatic zones, and that the effects of soil moisture content, soil temperature, clay content, and the soil N/P ratio were considerable." (P2, Line 46-49).

(2) Materials and Method: The investigation was conducted in July and August in three climate zones, It is better to illustrate the climate information of the investigation month and detail investigation date in each site. This is because the activities of microbe is very sensitive to the climates, especially the moisture and temperature.

AN: We illustrated the climate information of the investigation month in the text. The average temperature of the sampling month was 21.3 °C, 17.4°C, 27.3°C with the relative humidity of 78%, 60-65%, 83.5% in LS, TY, and DH, respectively. The sampling dates are Jul.5 2013, Jul.28 2013, Aug.15 2013 in LS, TY, and DH, respectively. (P5, Line133-136).

(3) Results: In the 3.1 section, the activities of four enzymes did not be described carefully. Most information were ignored, for example, there were not comparison between

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forest types in the same climate zone. And there were not comparison between different climate zones, for example, the LAP activities of microbes in worm temperate zone were much higher than that in temperate zone.

AN: We have added necessary description about the enzyme activities. The soil BG and NAG activities were much higher in the coniferous forest than in the conifer broad-leaved mixed forests and the broad-leaved forests (Table S2). The soil AP enzyme activities were highest in the conifer broad-leaved mixed forests and lowest in the coniferous forests (Table S2). (P8, Line205-208).

The soil BG, NAG, and LAP activities were much higher in the warm temperate zone than in the temperate and the subtropical climate zones (Table S2). The AP activities were highest in the subtropical climate zone (Table S2). (P8, Line 210-212)

(4) In the 3.2, same as 3.1, no comparison among three climate zones. Although there were difference among forest types in the same zone, authors should compare the similar quality forest such as SCB along three climate zones. If the results of these comparison could be reported, more mechanism of divergences among zones and forest types could be understood very well.

AN: We have added necessary description about the microbial communities. We compare the microbial PLFAs among the three different climate zones and three forest types (conifer broad-leaved mixed forest, broad-leaved forest, and coniferous forest), respectively.

The forest type had a significant effect on the soil bacteria, fungi, gram-positive bacteria (G+), and gram-negative bacteria (G−) PLFAs (Table 2). The soil total PLFAs, bacteria, G+, G−, and actinomycete were much higher in the conifer broad-leaved mixed forests than in the coniferous forests and the broad-leaved forests (Table S2). The soil fungi was highest in the broad-leaved forest and lowest in the coniferous forest (Table S2). (P8, Line221-226).

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With the exception of the soil G+/ G−, the effects of the combination of climate and forest type on all soil PLFAs were significant, and were stronger than the individual effects of either climate or forest type (Table 2, Table S2). Climate had a significant effect on the total PLFAs, fungi, and G− ($P<0.0001$) (Table 2). The soil total PLFAs, bacteria, G+, and G− were much higher in the temperate zone than in the warm temperate and the subtropical zones (Table S2). The fungi, F/B, and G+/G− were highest in the subtropical zone (Table S2). (P9, Line 227-232)

(5) In conclusion part, we would like to see the conclusion what changes along the climate zone could be found

AN: We have added description in the result and conclusions part about the variations in microbial communities and enzyme activities along the climate zone.

The soil BG, NAG, and LAP activities were much higher in the warm temperate zone than in the temperate and the subtropical climate zones (Table S2). The AP activities were highest in the subtropical climate zone (Table S2). (P8, Line 210-212)

With the exception of the soil G+/ G−, the effects of the combination of climate and forest type on all soil PLFAs were significant, and were stronger than the individual effects of either climate or forest type (Table 2, Table S2). Climate had a significant effect on the total PLFAs, fungi, and G− ($P<0.0001$) (Table 2). The soil total PLFAs, bacteria, G+, and G− were much higher in the temperate zone than in the warm temperate and the subtropical zones (Table S2). The fungi, F/B, and G+/G− were highest in the subtropical zone (Table S2). (P9, Line 227-232)

Conclusion: Except AP, soil enzyme activities were highest in warm temperate zone. Soil tPLFAs, bacteria, G− increased from temperate zone to subtropical zone, but fungi was in reverse. (P15, Line 404-406).

(6) Discussion: 4.1, It is unclear what the response of soil enzyme activies and microbial plfas to variation of forest types is. Authors should clearly discuss the variation

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partten and formation reseason.

AN: We have improved this part. Forests in the same climate zone developed similar microbe functions which confirmed the result that the effect of climate on soil enzyme activities were stronger than the forest type and their interactive effect. However, there were still differences among the enzyme activities in different forest types of the same climate zone. Soil microorganisms are usually considered to be C limited, and the litter inputs with high C/N ratio of PCB in the temperate zone will stimulate microbes to grow and secrete more enzymes (Table 1). Therefore, all enzyme activities were highest in PCB in the temperate zone. (P10, Line 264-270).

The high soil BG enzyme activities in the LOw forest in the warm temperate zone reflect the litter inputs with low C. Because that soil enzyme activities will not continuously increase or decrease as nutrient availability increases or decreases. When the soil nutrients are short in supply, microbes will potentially increase production of nutrient-acquiring enzymes, because they are expected to optimize the allocation of their resource reserves by acquiring the resource that is most limiting (Bloom et al., 1985). (P10, Line 270-275).

The interactive effect of climate and forest type were more important than the individual effect of them. Therefore, the soil microbial communities of the 12 forests were separated from each other. Vegetation transfers substrate material of varying quality to microbes through litter fall. Fungi are more suitable for life in environments containing higher C/N ratios and low soil pH (Nilsson et al., 2012). The four broadleaved forests were high in litter C/N ratio (Table 1). Therefore, fungi were dominated in this harsh nutrient environments and highest in broadleaved forests. The litter and soil from conifer broad-leaved mixed forest were high in C, N, and P, and promotes the propagation of bacteria that favor high-nutrient soil (Priha and Smolander, 1997; Priha et al., 2001). Therefore, the structures and functions of the soil microbial communities that developed in the different types of forest were unique. (P10, Line 277-283; P11, Line 284-286)

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To avoid the repetition with the 4.2 and 4.3, some more detail reasons of the variations were discussed later.

(7) 4.2, How to compare the commen effect and key effect? if there is obviose differece between two effects, could you explain the identification method of two effects.

AN: The common effect refer to the same environmental variables which are significantly correlated with the RDA1 in the three bioplots of the three climate zones ($P<0.05$). The key effect refer to the environmental variables those were more important in determining soil microbial communities and functions of the individual climate zones ($P<0.01$).

In addition, we have done a new RDA again by putting the data of 12 forests in the three climate zones together to observe the variations in soil enzyme activities (Fig.S1) and microbial communities (Fig.S2) among different forest types and climate zones.

(8) Conclusion: Authors should adress the main conclution of the variation of enzyme actiivities and microbial communnity among forest types along the three zones in the suitable part of the paragraph.

AN: We have added the main conclusion of the variations of enzyme activities and microbial community among forest types in the result and conclusion.

The soil total PLFAs, bacteria, G+, G−, and actinomycete were much higher in the conifer broad-leaved mixed forests than in the coniferous forests and the broad-leaved forests. The soil BG and NAG activities were much higher in the coniferous forest than in the conifer broad-leaved mixed forests and the broad-leaved forests. Except AP, soil enzyme activities were highest in warm temperate zone. Soil tPLFAs, bacteria, G− increased from temperate zone to subtropical zone, but fungi was in reverse. (P15, Line 401-406)

Minor mistakes

(9) line 135. authors should give detail information about collection such as which

samples were collected in July?

AN: The average temperature of the sampling month was 21.3 °C, 17.4°C, 27.3°C with the relative humidity of 78%, 60-65%, 83.5% in LS, TY, and DH, respectively. The sampling dates are Jul.5 2013, Jul.28 2013, Aug.15 2013 in LS, TY, and DH, respectively. (P5, line 133-136; Table 1).

(10) SCB in temperate zone was not same as it in Subtropical forest, it is better abbreviated as SCBt SCBs

AN: DONE (Table 1, Figure 1, Figure 2 and Figure 4).

(11) Fig. 2 ABCD was represent different enzyme activities, please check them.

AN: DONE (P24, Figure 1).

(12) The format of some references did not fit with the format of this journal such as New Physiologist which did not was abbreviated.

AN: DONE (P16, Line 436). We have checked all through the text and made necessary variations.

Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2017-243/bg-2017-243-AC1-supplement.zip

Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2017-243, 2017.

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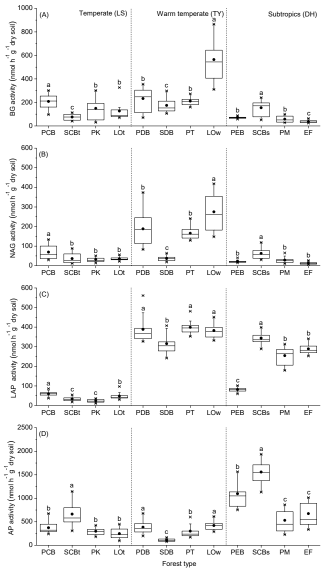

Figure 1. Soil enzyme activities under different forest types in different climatic zones. BG, b-1, 4-glucosidase; NAG, b-1,4-N-acetylglucosaminidase; LAP, leucine aminopeptidase; AP, acid phosphatase. The capital letters A, B, C, and D represent the variations in the enzyme activities of BG, NAG, LAP and AP, respectively. Different lowercase letters indicate significant differences between forests in the same climatic zone. The abbreviations of the sampling sites are shown in Table 1.

Fig. 1. Soil enzyme activities under different forest types in different climatic zones.

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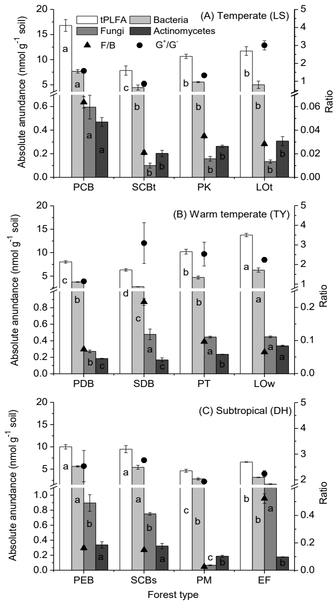

Figure 2. The PLFA contents, Fungi:Bacteria ratios, and G^{+}/G^{-} for different forest types in different climatic zones (A. Liangshui; B. Taiyue; C. Dinghu). Different lowercase letters indicate significant differences among forests in the same climatic zone. F/B, fungi/bacteria; G^{+}/G^{-}, Gram-positive bacteria/ Gram-negative bacteria. The abbreviations of the sampling sites are shown in Table 1.

Fig. 2. The PLFA contents, Fungi:Bacteria ratios, and G+/G− for different forest types in different climatic zones (A. Liangshui; B. Taiyue; C. Dinghu).

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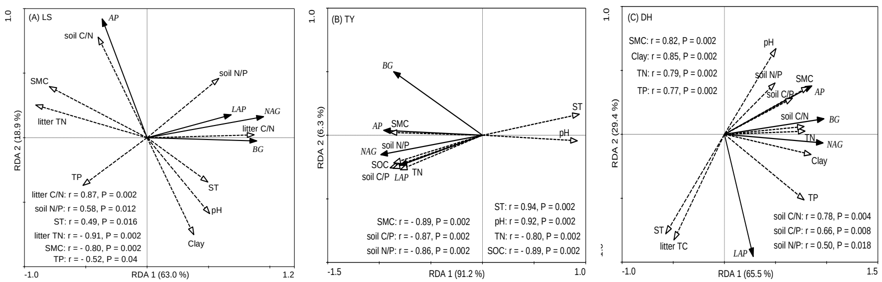

Figure 3. Redundancy analysis (RDA) ordination biplot of soil enzyme activities and environmental properties for the different forest types in different climatic zones (A. Liangshui; B. Taiyue; C. Dinghu). Only the environmental variables that were significantly correlated with RDA1 are shown. The dotted lines and solid lines represent the environmental variables and enzyme activities. The variables in this table were abbreviated as follows: TC(litter) = litter total carbon; TN(litter) = litter total nitrogen; C/N(litter) = litter total carbon/nitrogen; ST = soil temperature; SMC = soil moisture content; Clay = soil clay content; SOC = soil organic carbon; TN = soil total nitrogen; TP = soil total phosphorus; C/N = soil carbon/nitrogen; C/P = soil carbon/phosphorus, and N/P = soil nitrogen/phosphorus.

Fig. 3. Redundancy analysis (RDA) ordination biplot of soil enzyme activities and environmental properties for the different forest types in different climatic zones (A. Liangshui; B. Taiyue; C. Dinghu).

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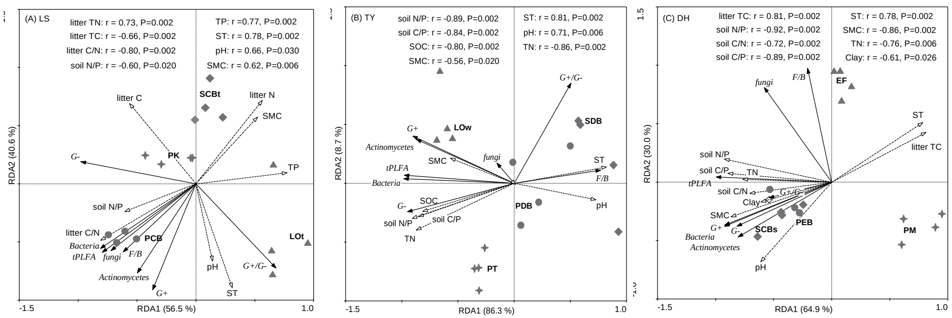

Figure 4. Redundancy analysis (RDA) ordination biplot of soil microbial community structure and environmental properties for different forest types in different climatic zones (A. Liangshui; B. Taiyue; C. Dinghu). Only the environmental variables that were significantly correlated with RDA1 are shown. The dotted lines and solid lines represent the environmental variables and lipid signatures. The abbreviations of the variables included in this figure are shown in Figure 4.

Fig. 4. Redundancy analysis (RDA) ordination biplot of soil microbial community structure and environmental properties for different forest types in different climatic zones (A. Liangshui; B. Taiyue; C. Ding

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