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Interactive comment on “Contrasting pH buffering patterns in neutral-alkaline soils along a 3600 km transect in northern China” by W. Luo et al.

W. Luo et al.

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Dear Reviewer, We would like to thank you for the constructive and helpful comments for our manuscript. We have carefully considered them and revised our manuscript accordingly. All other comments were also carefully considered and incorporated. Grammatical mistakes have been corrected throughout by our native co-authors. In order to make the changes easily viewable, we marked the main revision with color in the revised manuscript. Detailed responses to each comment are listed below. Response to reviewer 2: Question 1: Generally speaking the higher soil pH, the stronger soil pH buffering capacity. It is thus quite unusual that in carbonate-containing soil that there is a negative relationship between soil initial pH and soil pHBC. If this is true, soil initial pH would not have significantly positive correlation with carbonate, i.e., SIC. Since the

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authors determined SIC content, it is thus interesting to see what kind of correlation exist between initial soil pH and SIC. Reply: A new figure (i.e. Figure S5) showing the relationships between initial soil pH and soil inorganic carbon concentration has been added in the revised manuscript. In line with your expectation, a negative relationship between soil pH and inorganic carbon concentration was found, as shown in our revised manuscript. Yes, this result was quite unusual, which may be associated with higher sulfate in topsoil of this region. Question 2: In addition, it seems highly unlikely that non-carbonate containing soil released no any CO₂ gas upon 2M HCl addition. Pls explain. Reply: Thanks very much for your suggestion. Yes, it is difficult to separate carbonate containing soils and non-carbonate containing soils. In the Method Section, we have defined the non-carbonate soils as those from which we were unable to detect the CO₂ release upon addition of HCl (lower than the detection limit). Page 10 Line 206-208.

Question 3: Meanwhile, it is also likely that the protocol has some drawbacks for pHBC measurement. For example, how about pHBC measured by addition of H₂SO₄? The authors may briefly discuss the advantage and drawbacks of HNO₃-based pHBC measurements. Reply: Thanks very much for your comments. The reviewer is right that the pHBC can be measured by titrating soils with different kinds of acids, such as H₂SO₄, HCL, and HNO₃. However, the most widely accepted one is the use of HNO₃ as adopted by many standard soil analysis and testing protocols) (e.g., Bowman et al., 2008; Nelson and Su, 2010; Xu et al., 2012; Lu et al. et al., 2015), because the nitrate anion tends to have fewer interactions with soil materials than other anions. Question 4: Please provide data about the relationship between soil aridity and initial soil pH. Reply: A new picture (i.e. figure S6) showing the relationship between aridity index and soil pH was added in the revised manuscript as suggested by this reviewer. Question 5: In addition, please provide information about acidification process and rate of soils in northern China in the introduction section. The authors repeatedly stated that acidification rate and processes are important but they provide no solid evidence in support of these statements. Reply: Thanks very much for your valuable suggestions.

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In the revised manuscript, we have provided more information about soil acidification processes induced by nitrogen and sulfur depositions in northern China in the Introduction Section. Question 6: Page 13216 Lin 20-21. The authors present no data of rates, risks and impact of acidification. Reply: In the revised manuscript, we deleted these words according to the comment. Question 7: Page 13217 Line 1. Please delete some references as 7 might be too much for one statement. Or you can simply assign these reference to different topics you would like to emphasize Reply: According to the suggestion, we have deleted three of the references in the revised manuscript. Question 8: Page 13217 Line 21. The study in 1992 and 2000 are not recent studies. Reply: In the revised manuscript, we changed "recent studies" into "previous studies" according to the suggestion. Question 9: Page 13217 Line 11-18. I would like to see justification of why large-scale study is required. Reply: Thanks very much for your suggestions. A new section was added to show the importance of large-scale patterns of soil pHBC. Page 5 Line75-79. Question 10: Page 13217 Line 26. Please briefly explain the mechanisms of how high temperature, high evaporation and low precipitation can increase carbonate precipitation? Reply: Thanks very much for your suggestions. In the revised manuscript, we added a new section to show the mechanisms of how high temperature, high evaporation and low precipitation increase carbonate precipitation. Page 5 Line 75-79. Question 11: Page 13217 Line 29. I guess the authors may start this paragraph by saying there are three main pH buffering mechanisms in soils. And then explain it in detail. Reply: Thanks very much for your suggestions. In the revised manuscript, we have revised the manuscript according to the comment. Page 4 line 64-Page 5 Line 67. Question 12: Page 13218 Line 5. What is the cause of soil acidification in northern China? Nitrogen deposition or sulfur deposition, pls specify their relative contributions if flexible. Reply: We agree with you that this information is very important for predicting the acidification rates of this region. However, we did not found these data in the previous studies or via personal communication, and hence cannot provide the information in the current paper. We hope that this would not influence the content and framework of the manuscript. Question 13: Page 13219 Line 9. Please cite appropriate reference

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for Chinese soil classification. Reply: Thanks very much for suggestions and an appropriate reference has been added in the revised manuscript. Question 14: Page 13219 Line 11. What does soil fertility mean? Reply: Here, "soil fertility" may be not appropriate and was deleted. Question 15: Page 13226 Line 10. Replace who demonstrated with demonstrating Reply: Replaced as suggested. Question 16: Page 13226 Line 19. Delete between our results and previous results. Reply: We have deleted these words in the revised manuscript. Question 17: Page 13226 Line 20. It seems more likely to be associated with the structure (i.e. type) of soil organic matter rather than quantities. If it is caused by the quantities, then one would be able to see significant correlations. Reply: Thanks for your suggestions. We agree with you that it was associated with the structure (i.e. type) of soil organic matter rather than quantities. Hence, we deleted the "quantities and" in the revised manuscript. Question 18: Page 13228. The figure legend might be wrong. It is a mere correlation between longitude and initial soil pH, and pH change upon acid addition was shown in the inset? Reply: We think the confusion might be cleared up because we have changed that reference from Figure 2 to Figure 4. Question 19: Page 13229. It is quite perplexing that there is soil inorganic carbon in non-carbonate soils. Reply: You may mean page 13239. The transect was divided into carbonate containing soils and non-carbonate containing soils. Hence, there is no inorganic carbon in the non-carbonate containing soils, or the tiny amount of CO₂ released was not detected.

We have also revised the whole manuscript thoroughly to improve the overall quality of the manuscript. All changes are marked in color in the revised manuscript. Once again, thank you very much for your comments and suggestions.

Kind regards, Wentao Luo

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Response to reviewer 2:**Question 1:**

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Question 2:

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Fig. 1. Response to the comments from reviewer 2

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