

Interactive comment on “Contribution of the nongrowing season to annual N₂O emissions from the continuous permafrost region in Northeast China” by Weifeng Gao et al.

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Dear Prof. Song: Thank you for your letter and the constructive comments on our manuscript entitled “Contribution of the nongrowing season to annual N₂O emissions from the continuous permafrost region in Northeast China” (No.: bg-2020-305). Those comments are very helpful for revising and improving our paper. We have revised the manuscript carefully according to the comments, which we hope meet with approval. All the responses to your comments are as following:

Major comments Thank you for your approval of the design of the study and interpretation of the results. While, this manuscript was different with the previous paper

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published in Atmospheric Environment (2019, 214, 116822). The previous published paper (Atmospheric Environment, 2019) was mainly focus on the response of N₂O emissions to spring thaw period (March 17 to May 23, 2017) in the permafrost region. The authors investigated N₂O emissions from a permafrost region in response to spring thaw period; explored the influence of swamp forest types on soil N₂O emissions during spring thaw period; quantified the environmental drivers of N₂O emissions during spring thaw period; and compared N₂O emissions with those from growing season in the permafrost region and those from other ecosystems during spring thaw period at global scale. The scientists had been studied N₂O emission during the growing season and spring thaw period in the permafrost region of Daxing’an mountains. However, little is known about the characteristics of nongrowing season N₂O emissions from the permafrost region of Daxing’an mountains, as well as global scale of permafrost region. In this study, we measured two full-year around (June 2016 to June 2018) N₂O emissions from the permafrost regions of Daxing’an mountains. We are mainly focus on the seasonal dynamics of nongrowing season N₂O emissions and its contribution to the annual budget. We found that the nongrowing season N₂O emissions were ranged from -35.75 to $74.16 \mu\text{g}\cdot\text{m}^{-2}\cdot\text{h}^{-1}$ in the permafrost region of Daxing’an mountains, which were mainly lower than that from growing season. The mean soil temperature controlled the mean N₂O emissions from growing season, spring thaw period and nongrowing season. The cumulative N₂O emissions from nongrowing season contributed to 41.96–53.73% of the annual budget, accounting for almost half of the annual emissions in the permafrost region, which was an important component of annual emissions and cannot be ignored in the permafrost region. Our results proved the observation of the nongrowing season N₂O emissions from permafrost regions is of great significance for the accurate assessment of regional N₂O emission in the permafrost regions.

Detail comments 1. Please add an aerial photo showing the sampling locations. The authors’ answer: Thank you for your meaningful suggestion. We have added the vegetation and sampling location photo.

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2. Line 24, 25, and line 51, “permafrost are thawing” not “permafrost regions are thawing”. The authors’ answer: Thank you for your comment. We have replaced the “permafrost regions are thawing” with “permafrost are thawing”.
3. Page 6 line 133, investigations? The authors’ answer: We have revised it. We used the investigate instead of investigations.
4. Page 6 line 128, the soil type should be given according to the USDA classification system, The authors’ answer: Thank you for your comment. The soil type were Gelisols according to the USDA classification system. We have revised it.
5. Page 8, table 1, the unit of data is missing. The meaning of small letter in the table should be given in footnote. The authors’ answer: Thank you for your meaningful suggestion. We have added the unit of the soil physical and chemical factors. In the footnote, we added the meaning of small letter in the table.
6. The title of the paper is Contribution of the nongrowing season to annual N₂O emissions, Page 8 line 181, Gas samples were taken monthly during the winter from October to December, the time interval is too long The authors’ answer: Thank you for your meaningful suggestion. It’s true that the time interval in winter was a little long. In 2019, we measured the N₂O emissions during the autumn freeze-thaw period (September 27 to November 11) (Zeng, 2020). The autumn freeze-thaw period was an important part of the winter. During the autumn freeze-thaw period, environmental factors were changed dramatically, which would release a large amount of N₂O emissions same as the spring freeze-thaw period. However, the results show that the mean N₂O emissions were 2.32 ± 4.92 , 3.37 ± 4.10 and $1.06 \pm 2.64 \mu\text{g m}^{-2} \text{h}^{-1}$ from LL, LC and BC sites, respectively (Zeng, 2020). The spatial variation of N₂O emissions were very small. T We didn’t measure the N₂O emissions from middle of November to the end of December. We speculate that the change of N₂O emissions would very small due to the soil was freezing. In the future, we would add the sampling frequency of the winter. Reference Zeng QB. Analysis of greenhouse gas flux and global warming

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potential in different permafrost zones of Daxing’an mountains. Harbin: Harbin Institute of Technology, 2020. (In Chinese)

7. Page 11 line 212, mol/L should be mol L⁻¹. The authors’ answer: We have replaced mol/L with mol L⁻¹.
8. Page 13 line 265, A and B in the figure title should be a and b. The authors’ answer: Thank you for your comment. We have revised it.
9. Page 29 line 465, release of N₂O emissions. The authors’ answer: We have deleted the “released of”.
10. Page 29 line 469, nongrowing season and line 271 non-growing seasons. The authors’ answer: Thank you for your suggestion. We have revised it.
11. Page 30 line 487, mouths? The authors’ answer: That’s my spelling mistake. We have revised it.
12. Page 30 line 488, spring thaw spring? The authors’ answer: Thank you for your comment. We have replaced spring thaw spring with spring thaw period.

Thank you for your comments; we are happy to make additional revisions if needed.

Sincerely, The authors,

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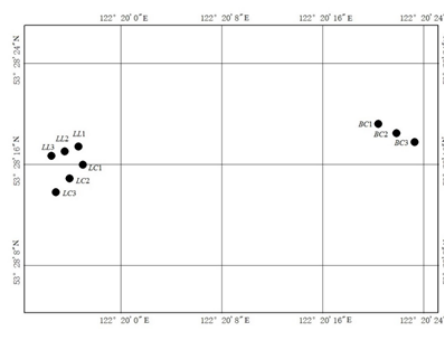
(a) *LL* swamp forest



(b) *LC* swamp forest



(c) *BC* swamp forest



(d) Location of the study site

Fig. 1. The vegetation (a, b and c) and location (d) of the study site in the Daxing'an Mountains, northeast China.