

Interactive comment on “Different responses of CO₂, CH₄, and N₂O fluxes to seasonally asymmetric warming in an alpine grassland of Tianshan Mountains” by Yanming Gong et al.

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Anonymous Referee #1 I have reviewed this paper by Gong et al. This study revealed the effect of seasonally asymmetric warming on greenhouse gas fluxes in alpine grassland, and it advances our understanding of warming effects on greenhouse gas fluxes. I think there are a few minor issues that could be improved Before it could be accepted for publication. 1) The authors should focus more on the mechanisms behind the different responses of greenhouse gas fluxes to seasonally asymmetric warming. Response: Thank you for your precise comment. We revised the manuscript. L421-438, “Ecosystem CH₄ flux is the net result of CH₄ production and consumption occur

C1

simultaneously under the action of methanogenic archaea and methane-oxidizing bacteria (e.g., Mer and Roger, 2001; Blodau, 2002; Galbally et al., 2008). CH₄ fluxes are dependent on temperature, pH, and the availability of substrate (e.g., Moore & Dalva, 1997; Treat et al., 2015). For example, lower levels of soil moisture would decrease C release, indicating that drier soils are the major CH₄ sink (Denman et al., 2007). The CH₄ uptake observed during the three growing and non-growing seasons implied that the alpine grassland soil could act as an atmospheric CH₄ sink, which agrees with the findings of many previous studies in similar region (Li et al., 2015; Wei et al., 2015; Zhao et al., 2017; Wu et al., 2020). As well as, our results demonstrated that warming increased CH₄ uptake in the growing season, but decreased CH₄ uptake in the non-growing season in the alpine grassland, similar to the results from other grassland ecosystems (Lin et al., 2015; Zhu et al., 2015; Wu et al., 2020). Moreover, a warming-induced soil moisture decrease may be a potential mechanism for the positive influence of warming on soil CH₄ uptake in the alpine grassland (Lin et al., 2015). Our results also demonstrated that seasonally asymmetric warming did not significantly affect the response rate of CH₄ uptake to temperature increase (Figure 2 d-f, $P > 0.05$).” L441-502, “Unlike CH₄ fluxes in alpine grasslands, Treat et al. (2018) confirmed that nongrowing season wetland were small CH₄ sources, and uplands varied from CH₄ sinks to CH₄ sources.” L515-518, “As well as N₂O emissions was positively related to soil temperature, Pärn et al. (2018) found that N₂O emission from organic soils increases with rising soil NO₃⁻, follows a bell-shaped distribution with soil moisture.” L512-518, “However, our results displayed emissions peaks of N₂O during the freeze–thaw periods (e.g., May 2017, June 2018 and April 2019). Warming increased N₂O emissions in the thawing period owing to disrupt the gas diffusion barrier and greater C and N availability for microbial activity (Nyborg et al., 1997). Wagner-Riddle et al. (2017) also confirmed that the magnitude of freeze–thaw-induced N₂O emissions was related to the number of days with soil temperatures below 0 °C”

2) There are a few minor things needed to be revised throughout the manuscript. For example, Line 16: “greenhouse gas flux” should be changed to “greenhouse gas

C2

fluxes"; Line 154: "Figure 2" should be "Fig. 2" to be consistent with other places. Response: Thank you for your precise comment. Line 16: we revised as "greenhouse gas fluxes". See L20 of the revised manuscript.

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