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Interactive comment on "Different responses of CO_2, CH_4, and N_2O fluxes to seasonally asymmetric warming in an alpine grassland of Tianshan Mountains" *by* Yanming Gong et al.

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Thank you for your comments and the reviewers' comments concerning our manuscript entitled " Different responses of CO2, CH4, and N2O fluxes to seasonally asymmetric warming in an alpine grassland of Tianshan Mountains" (MS No.: bg-2020-396). Those comments are all valuable and very helpful for revising and improving our paper, as well as the important guiding significance to our researches. We have studied those comments carefully and have made a point to point reply and correction. Revised portion are marked in red color in this manuscript. Specific corrections and responds to the reviewer's comments are listed as follows:

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Comments to the Author: # the comment by Y.G. Du This manuscript describes the response of GHGs emissions to seasonally asymmetric warming in an alpine grassland of Tianshan Mountains. It is an interesting topic to understand carbon and nitrogen cycles with increasing temperature. The manuscript is well written and concise. The experiment is well designed and conducted. I suggest this manuscript could be accepted after some minor revisions. Introduction: the research advances of responses of CO2, CH4 and N2O fluxes to seasonally asymmetric warming is very limited, more contents could be added especially in grassland ecosystem. Authors quoted many IPCC results about warming and its effect on GHGs fluxes, which need to be summarized. Response: Thank you for your precise comment for the Introduction. We have added to the latest research on the effect of warming on greenhouse gas flux in grassland ecosystems. Add the following: “A recent study showed that seasonal variations in carbon flux were more related to air temperature in the meadow steppe (Zhao et al., 2019). Another study found that experimental warming enhanced CH4 uptake in the relatively arid alpine steppe, but had no significant effects on CH4 emission in the moist swamp meadow (Li et al., 2020). Wu et al. (2020) also showed that the warming did not significantly affect soil CH4 uptake fluxes in the alpine meadow of the Tibetan Plateau. Furthermore, a global meta-analysis (Wang et al., 2019) showed that experimental warming stimulates C fluxes in grassland ecosystems, and the response of C fluxes to warming strongly varies across the different grassland types, with higher warming responses in cold than in temperate and semiâĂŘarid grasslands. Across the data set, Li et al. (2019) demonstrated that whole day or whole year warming treatment significantly enhanced N2O emissions, but daytime, nighttime or short season warming did not have significant effects.” See L175-187 of the revised manuscript. We also summarized the IPCC results about warming and its effect on GHGs fluxes. The revised content is as follows: “The 3th and 4th assessment report of the Inter-Governmental Panel on Climate Change (IPCC) proposed that, against the backdrop of global warming, the temperature change will show that the warming amplitude in winter is greater than that in summer, and the warming amplitude at high latitude is greater than that at

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low latitude, and confirmed that the warming shows asymmetric trends on a seasonal scale (Easterling et al., 1997; IPCC, 2001; IPCC, 2007)." See L86-91 of the revised manuscript.

Materials and methods: air temperature and precipitation data of growing season and non-growing season could not be found, which are important to explain the effect of seasonally asymmetric warming on GHGs flux. Response: Thank you for your comment for the Materials and methods. We have presented air temperature and precipitation data through tow figures. And described the Figure S3 and S4 in the revised manuscript.

Figure S3 Variation in air temperature (inside the OTC, 50cm above the ground) under four treatments in alpine grassland from October 2016 to September 2019. GS, growing season; NGS, non-growing season; AW, warming throughout the year; NGW, warming in nongrowing season only; GW, warming in growing season only; NW, non-warming. Significant differences among AW, NGW, GW and NW from analysis of variance (ANOVA) are denoted as bars within the same season with different lowercase letters, $P < 0.05$; data points are the mean $\pm$ standard error.

Figure S4 Variation in precipitation in the alpine grassland from October 2016 to September 2019. GS, growing season; NGS, non-growing season.

Discussion: please delete figure 2 and $P < 0.05$ or $P > 0.05$. The manuscript do not research the response of GHGs to daytime, nighttime or short-season warming, please delete it. Response: Thank you for precise comment for the Discussion. However, we disagree with this comment. Figure 2 shows the highlights of this manuscript: "Response of variations in CO2, CH4, and N2O fluxes to changes in soil temperature under AW, NGW and GW conditions in the alpine grassland, from 2016 to 2019." Figure 2 does not mention what the comments suggest: "the response of GHGs to daytime, nighttime or short-season warming"

Conclusions: please add the responses of CH4 and N2O fluxes to warming in the

study. Response: Thank you for your precise comment for the Conclusions. We have revised the conclusion as “In summary, the effect of seasonally asymmetrical warming on CO2 and N2O fluxes were obvious, but not CH4 flux, with the CO2 and N2O fluxes being able to adapt to continuous warming, resulting in a reduced response rate of the CO2 and N2O fluxes to temperature increase. Warming in the nongrowing season increased the temperature dependence of the CO2 flux. Thus, we believe that the study of climate change should pay greater attention to warming in the nongrowing season, so as not to underestimate the greenhouse effect of the CO2 flux in alpine grasslands.” See L535-541 of the revised manuscript.

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Different responses of ecosystem respiration, CH_4 uptake, and N_2O emissions to seasonally asymmetric warming in an alpine grassland of Tianshan Mountains

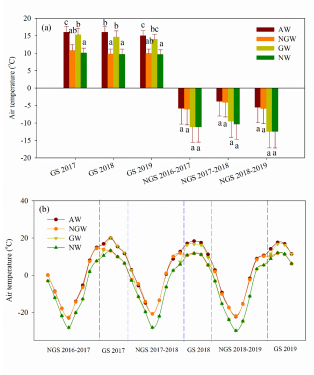

Figure S3 Variation in air temperature (inside the OTC, 50cm above the ground) under four treatments in alpine grassland from October 2016 to September 2019. GS, growing season; NGS, non-growing season; AW, warming throughout the year; NGW, warming in nongrowing season only; GW, warming in growing season only; NW, non-warming. Significant differences among AW, NGW, GW and NW from analysis of variance (ANOVA) are denoted as bars within the same season with different lowercase letters, $P < 0.05$; data points are the mean ± standard error.

Fig. 1.