General comments

The manuscript titled "Different responses of ecosystem respiration, CH_4 uptake, and N_2O emissions to seasonally asymmetric warming in an alpine grassland of the Tianshan Mountains" by Gong et al. talks about the responses of the three GHG fluxes viz., CO_2 (ecosystem CO_2 efflux), CH_4 and N_2O to different seasonal (growing and non-growing season) and annual experimental warming across 3 years in an alpine grassland on southern Tianshan mountain.

The manuscript investigates an important question with a strategic experimental design and intensive data collection. Most questions raised so far have been answered and revisions made are acceptable. In spite of this the manuscript in the current state has significant drawbacks due lack of information at some places. At other places information is given without providing the context for the same.

The manuscript requires further revision and the general concerns are given below:

- Lack of information in methodology regarding OTC installation strategy, selection of sampling time of GHG fluxes, microclimatic parameters measured and few data analyses.
- The discussion does not flow from results and at places results are written in discussion section (example line no. 251-260). The discussion section focuses on response rates (RR) of GHG fluxes but the results section does not mention RR.
- It is suggested to compute Q_{10} which is a direct and widely used parameter to assess temperature sensitivity (see Zhou et al., 2016 "Experimental warming of a mountain tundra increases soil CO_2 effluxes and enhances CH_4 and N_2O uptake at Changbai Mountain, China").
- The magnitude of temperature increase (both air and soil) inside open-top chambers should be mentioned. The study is based on the premise of significant warming within the OTC; however, figures indicate otherwise. The air temperature did not significantly increase during non-growing season in any of the plots (GW, NGW and AW) whereas the soil temperature did not significantly increase in any of the season (both growing and non-growing) and plots in the entire 3-year study. Though non-significant, there is an increasing trend in temperatures inside OTCs which should be discussed.
- Findings indicate strong influence of moisture on the GHG fluxes and should be discussed. Both R_e (during growing season) and N_2O uptake varied interannually, coinciding with the variations in moisture. The study area is comparatively drier in

comparison to other alpine grasslands of the world hence moisture is likely to be a limiting factor. Moisture reduction inside OTCs can have significant influence on microbial enzyme activities and eventually on uptake and emission of GHGs.

Section wise comments for major revision

Introduction

1. The hypothesis does not directly relate to the objectives or the results of the work as the study focuses on seasonally asymmetric warming and continuous measurement of *Re* and CH_4-N_2O fluxes over 3-years.

Methodology

2. When were the OTCs installed or removed? Please clarify? For example, "for continuous annual warming OTCs remained installed since the beginning of the study while for growing season warming, these were installed at the onset of growing season and removed at the end of growing season…."
3. Why was the sampling performed only between 12:00 and 14:00 (GMT + 8) every day (line no. 133-134)? Was this time standardisation based on time interval coinciding with mean of diurnal (over 24 hrs) flux rates?
4. Line no. 116 states that all the plots were ungrazed since 2005, how was this achieved? I assume the plots or the entire site was fenced. Please clarify?
5. Measurement of soil temperature and soil moisture at 10 cm depth by data loggers were made at what frequency? hourly or daily? How air temperature was measured or recorded inside all the 4 experimental plots and at what height?
6. Line no. 134 states that the gas samples were collected every day while line no. 139, in contrast, states that they were collected once or twice a week. Clarify.
7. Line no. 138-139 states that "A total of 232 samples were taken, collecting once or twice a week" however figure 2 shows that n = 232 only for the growing season of 2017 whereas n= 192 for GS 2018 and n= 128 for others. Kindly correct.
8. One-way ANOVA was performed to compare only soil temperature (line no. 144). As Figures S2 and S3 indicate that you performed ANOVA for soil moisture and air temperature also, correct your statement.
9. General linear analysis was carried out between soil temperature and GHG fluxes only. The same analysis could be repeated for soil moisture also.
10. Use of variation partitioning analysis in figure 4 should be mentioned under methodology.

Results

11. Results of all the GHG fluxes under warming have been given in terms of increase or decrease however, the ANOVA results do not show significant difference, which should be mentioned and discussed. For example, in line no. 160-161: "Compared with the control group (NW), the *Re* was decreased by 7.5% and 4.0% in the growing season and non-growing season, respectively, under AW" add "however non-significant" Alternatively, write line no. 175-179 (stating ANOVA results) before line no. 160, so as to report in the beginning only, that the differences were not significant.
12. Line no. 172: increase in N_2O emission by 101.9% and 192.3% under AW and NGW in the growing season seems very high. Please check.
13. The authors may fit an exponential curve to determine the relationship between Re and soil temperature at 10 cm depth. Figure S5 a indicate towards an exponential pattern.

Discussion

14. Results should report response rates (only given in discussion section). The low r^2 value of linear regression in Figure 3 (where significant) should be discussed.
15. Line no. 251-260 merely gives results of variation partitioning analysis without any interpretation. This analysis should be mentioned in methodology and in result section.

Minor edits

Line 1: Although it is known that ecosystem respiration means CO_2 emissions, why not specify CO_2 instead for coining "respiration" as done for other gases (as done in the previous draft). This will avoid ambiguity in title. for example,

"Different responses of ecosystem CO_2 and N_2O emissions and CH_4 uptake to seasonally asymmetric warming in an alpine grassland of the Tianshan Mountains"

Also delete comma after CH_4 uptake.

Line 16-19: specify percentage increase for each GHG flux.

Line no. 26: remove comma after annual warming.

Line no. 31: (i) Write greenhouse gas fluxes instead of flux, (ii) as the manuscript doesn't include temperature sensitivity as objective and it has not been calculated, it is not logical to use it as a keyword.

Line no. 35-37: Shorten the sentence as "The global surface temperature increased by about 0.85°C from 1880 to 2012 and is expected to increase by about 1.1–6.4°C by the end of this century (IPCC, 2007, 2013).

Line no. 38: remove comma after scale.

Line no. 52: The warming or the temperature sensitivity of the GFG fluxes have not been evaluated in the study and hence “and their sensitivity to warming” may be removed.

Line no. 60. Remove space between numeric and percentage sign. Follow this in the entire manuscript.

Line no. 62: what do you mean by CO_2 fluxes? Is it respiration (if yes is it soil or ecosystem) or photosynthesis or both? Consider this in Line no. 78 also.

Line no. 63-67: as you are stating the result of specific study (Lin et al., 2015), it is better to start the sentence as “Lin et al. (2015) reported….”. Also give the percentage increase in CH_4 uptake under growing season also. Alternatively, you may add more references of the studies showing similar results, in this the percentage increase may be removed.

Lime no. 85: replace GHG flux with GHG fluxes. Follow this in Line no. 88, 98, 100.

Line no. 111: add space between −4.8 and °C.

Line no. 157-159: Figure 1 does not show the annual mean values of each flux but the variations during each year and hence the reference to figure 1 in this sentence is redundant.

Suggestions

1. Microclimatic parameters such as air and soil temperature and soil moisture are important to understand variations in seasonal, inter-annual and the asymmetric warming effect on GHG fluxes. Hence these should be included in the main text and their methodology and results should be stated and used while interpreting warming or inter-annual effects on GHG fluxes.
2. Calculate Q_{10} values (atleast for ecosystem respiration). This will give you a more direct indication of temperature sensitivity changes with warming. As most studies use this approach, it will be useful for comparison.
3. In Figure 2, it is suggested to add boxes for mean (entire study period) of each flux rates during growing and non-growing season under four treatments along with ANOVA results (as letters).