Response to reviews of manuscript "Excess radiation exacerbates drought stress impacts on stomatal conductance along aridity gradients" bg-2022-50

Response to reviewer#2

Dear Reviewer,

We would like to thank you for the thoughtful and valuable comments and suggestions on our manuscript entitled "Excess radiation exacerbates drought stress impacts on stomatal conductance along aridity gradients" (bg-2022-50). We have carefully revised our manuscript to take account of your comments and suggestions. Meanwhile, we have rephrased our manuscript title as "Excess radiation exacerbates drought stress impacts on canopy conductance along aridity gradients".

Here are the point-to-point responses (responses in upright Roman in black front) to the comments (original queries in Italic in blue front).

General comments:

1) The second hypothesis does not make sense to me. It is an abrupt hypothesis, as authors described in earlier paragraphs that solar radiation and temperature can have both positive and negative impacts on gs. It would be useful to added the basic climatic context for the three grassland transect.

Response: Thank you very much for your comment. We respond to this comment from three aspects.

(1) We clarified that "However, previous studies showed that the direction and intensity of solar radiation and temperature on gs strongly depend on their distribution range and the relationship with aridity. For example, the response of g_s to solar radiation and temperature generally shows an increasing trend up to optimum values (Xu *et al.* 2021), while excess radiation (Costa *et al.* 2015; Doupis *et al.* 2020; Zeuthen *et al.* 1997) and high temperature associated high VPD or low SM (Seneviratne *et al.* 2010) would suppress g_s."

(2) We added the basic climatic context for the three grassland transect in the last paragraph of "**1 Instruction**" section: "The grassland transect span gradients of precipitation, SM, VPD, solar radiation, and temperature, provide an ideal platform for exploration of interactive effects of multiple stressors and biotic factors on G_s (Table S1). In addition, the three grassland transects experienced with different soilar radiation and temperature conditions at a given aridity, due to the difference in the geographical location of the three plateaus. The order of mean annual temperature and solar radiation is LP>MP>TP and LP<MP<TP, respectively."

(3) We rephrased the second hypothesis as: "high solar radiation and low temperatures will jointly suppress Gs at a given aridity among transects. ".

2) It is essential that the authors to discuss the influence of temperature and VPD on △18O spanning large altitudinal and/or latitudinal gradients, because temperature and VPD may lead to large inter-site offsets in leaf δ18O values.

Response: Thank you very much for your comment. We respond these comments from two aspects in section "Discussion".

(1) We clarified that the decreasing trend of community $△^{18}O$ along aridity may originated from temperature and VPD through their effects on evaporation and isotopic exchange between water and organic molecules: "The decreasing trend of community $△^{18}O$ along aridity may originated from temperature and VPD through their effects on evaporation and isotopic exchange between water and organic molecules (Barbour & Farquhar 2000; Helliker & Richter 2008; Song *et al.* 2011). For example, the equilibrium fractionation factor for water evaporation is depend on temperature (Bottinga & Craig 1968). Temperature and VPD gradients between leaf and ambient air influence the evaporative gradient from leaf to air (Helliker & Richter 2008; Song *et al.* 2011). In addition, biochemical ^{18}O-fractionation during cellulose synthesis is sensitive to temperature, and the proportion of oxygen in cellulose derived from source water was humidity-sensitive (Hirl *et al.* 2021)."

(2) We demonstrated that the potential effects of temperature and VPD on $△^{18}O$ via evaporation and isotopic exchange between water and organic molecules could be ruled out in this study: "The potential effects of temperature and VPD on $△^{18}O$ via evaporation and isotopic exchange between water and organic molecules could be ruled out in this study. The growing season temperature variation was small along three transects (LP=3.3 °C, MP=4.9 °C, and TP=3.8 °C) (Table S1). However, the range of community $△^{18}O$ was 7.78‰ in LP, 3.89‰ in MP, and 6.17‰in TP (Table S1, Fig.2a). Previous studies demonstrated that the sensitivity of temperature to $△^{18}O$ was approximately 0.23‰/°C (Helliker & Richter 2008; Song *et al.* 2011). It seems that the changes in temperature was not a main contributor to the large variability in community $△^{18}O$. Meanwhile, positive relationship between community $1/△^{18}O$ and temperature was observed in LP ($P<0.05$), and negative relationship between community $1/△^{18}O$ and VPD was observed in TP (Table 1). However, partial correlation analyses showed that community $1/△^{18}O$ was not related to temperature ($P > 0.05$) and VPD after controlling for G_s (Data were not shown). It indicated that the variability in community $1/△^{18}O$ was mainly determined from G_s."

Specific comments:

1) Line 109: replace "plats" with " plots".

Response: Corrected, thank you.

2) Lines 175-177, partial correlation analyses can be used to examine the actual links between 1/△18O and soil moisture and vapor pressure deficit in Tibetan Plateau.

Response: Corrected and rephrased as: "Partial correlation analyses showed that 1/△^{18}O was not related to SM (P > 0.05) after controlling for VPD, indicating that variability in 1/△^{18}O in TP was mainly determined by VPD."

3) Figure 4, please add the meaning of the asterisks and arrows.

Response： To avoid confusion, we split Figure 4 into two graphs (Figure 4 and Figure 5). Meanwhile, the meaning of the asterisks and arrows have been added.

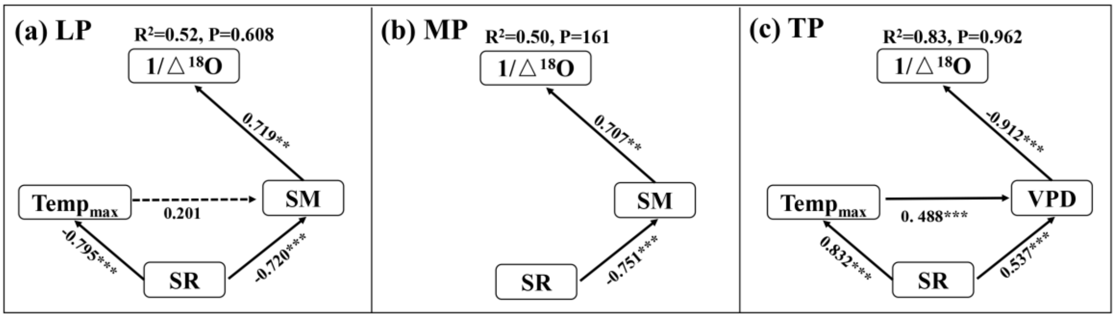

Figure 4. Structural equation models of abiotic factors explaining 1/△^{18}O in Loess Plateau (LP) (a), Inner Mongolia Plateau (MP) (b) and Tibet Plateau (TP) (c). △^{18}O, ^{18}O enrichment of leaf organic matter above source water; $Temp_{max}$: maximum temperature; SR, solar radiation; SM, soil moisture; VPD, vapor pressure deficit. Solid and dashed arrows represent significant and non-significant relationships in a fitted SEM, respectively. ***, P<0.001; **, P<0.01; *, P<0.05.

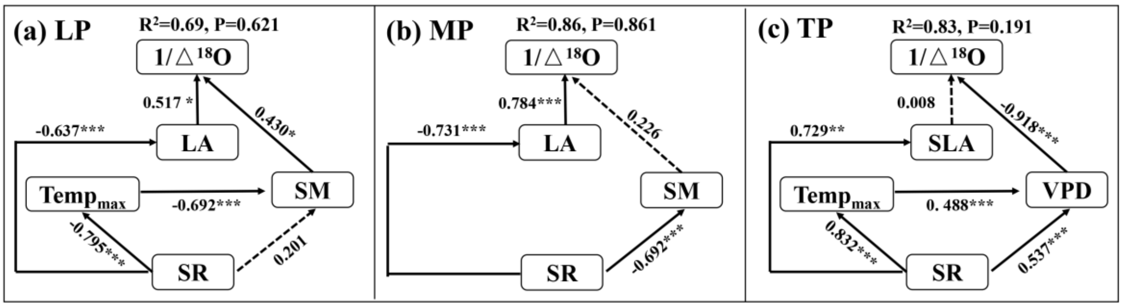

Figure 5. Structural equation models of abiotic and biotic factors explaining 1/△^{18}O in Loess Plateau (LP) (a), Inner Mongolia Plateau (MP) (b) and Tibet Plateau (TP) (c). △^{18}O, ^{18}O enrichment of leaf organic matter above source water; $Temp_{max}$: maximum temperature; SR, solar radiation; SM, soil moisture; VPD, vapor pressure deficit. LA, log-transformed leaf area; SLA, log-transformed specific leaf area. Solid and dashed arrows represent significant and non-significant relationships in a fitted SEM, respectively. ***, P<0.001; **, P<0.01; *, P<0.05.

4) Line 270, SLA integrates leaf tissue density and thickness.

Response: Thank you very much for your comment. This sentence has been removed, and this paragraph has been corrected and rephrased as: "Our preliminary study demonstrated that g_s was significantly affected by LA at species level in TP (Wang & Wen 2022). However, the effect of community LA on G_s was weak (P=0.061) (Fig.S5a), and variability in G_s along an aridity gradient was controlled by specific leaf area (SLA) (Table 1, Fig.S5b).This highlighted the difference in the biological drivers of g_s at leaf and canopy scales. Contrary to the results of the dry grassland species in Mediterranean (Prieto *et al.* 2018) and karst communities in subtropical regions (Wang *et al.* 2021), community 1/$\triangle^{18}$O significantly decreased with SLA in this study (Table S1, Fig.S5). It indicated that the traditional leaf economic spectrum theory may not existed at community level in TP due to the multiple environmental stressors. SLA generally decreases with increasing solar radiation, and increases with temperature and water availability (Poorter *et al.* 2009). In this study, commumnity SLA was negatively related to soil moisture, and positively related to maxmium temperature (Table S5). It indicated that changes of commumnity SLA was mainly controlled by maxmium temperature. However, the direct effect of SLA on G_s in the structural equation was not significant (Fig.5c). This effect may be obscured by drought stress.”