Associate editor

After carefully reading the reviewers' comments and your replies to them, I have concluded that your work could be considered for publication after thorough revision in accordance with your responses to the reviewers' comments and suggestions. Please be sure to respond carefully to the reviewers' comments and incorporate them in your revision. Some of your answers, particularly to reviewer #2's comments, are somewhat unspecific, for example already to reviewer #2's first comment:

"L147: How did you define "limited human interference"?

Answer: Grazing is the main land use mode in Mongolian plateau steppe. "Limited human interference" mainly refers to the selection of areas with less human activities such as grazing for investigation. The species composition, community structure and habitat were consistent within the community. There are fewer degenerate indicators."

This is not a sufficiently detailed reply. It is still unclear what objective criteria were used to make the selection. The statement "…were consistent within the community. There are fewer degenerate indicators" leaves the reader with more questions. And there are several more examples. In short, please be as precise as possible in your explanation.

Answer: Thank you very much for your advice. I have revised the manuscript based on the reviewers' comments and suggestions, and added responses to the comments.

Referee #1

This paper studied the response of three dimensions of biodiversity of grassland in different periods of climate change, and formed a theoretical framework for their impacts on community biomass, based on 152 grassland sites set on Mongolia Plateau. It's a good job.

My only concern is that, were the community biomass measured in the same year or not? If there're measured in the same year, is it a good year or a bad year (biomass always varies greatly from year to year, especially for grassland)? Data matching is always a big problem. Data on meteorological and plant functional traits used in this paper are obtained as interpolated or observed averages, whereas data of community biomass are measured values.

Answer: Thank you very much for your comments. Community biomass is not

measured in the same year. The modern climate used in this study is the average of the climate data from 1979 to 2013, which is a relatively long-term data. The data can reflect the current climatic gradient of the whole Mongolian Plateau. Observed mean values were used for plant trait data in this study, which is also used in many documented studies to reflect modern plant functional traits. In this study, the current climate, plant functional traits and biomass data reflect the current state. The spatial-temporal scale of this study is larger, and in the context of long time series, the impact of short-term fluctuations (i.e. the modern climatic factors) is relatively small.

Minor commences:

Line 10: Pastoral

Answer： I have amended this (L10).

Line 49: 'biodiversity and ecosystem functions' is not one word.

Answer： I have changed it to "ecosystem functions" (L48).

Line 60: the abbreviation of BEF is not appropriate here.

Answer： I have removed the abbreviation (L 59).

Line 80: need reference.

Answer： I added references (L80).

Line 82: the location of the reference is inappropriate.

Answer： I have removed the inappropriate reference (L81).

Methods: Why five indicators of functional diversity were selected, while only three indicators of other two kinds of diversity were selected? Would it affect the results of their "relative effect"?

Answer： First, the five functional diversity indicators present different aspects of functional diversity. The functional richness (FRic) represents the amount of niche space occupied by the species within a community. The functional evenness (FEve) is used to represent the evenness of the distribution of abundance in niche space. The functional divergence (FDiv) reflects the degree of niche differentiation within a

community. Rao's quadratic entropy ((Rao's Q) represents the difference between species and its proportion in the community. Functional dispersion (FDis) can be applied to multi-dimensional traits space and various types of traits. Secondly, in many research on the relationship between biodiversity and ecosystem function, the number of indicators for each dimension of biodiversity is different (Kang et al., 2020; Jochum et al., 2020; Le Bagousse-Pinguet et al., 2019). Finally, according to the results of this study, although functional diversity has five indicators, it has the least impact on biomass. Therefore, this does not affect the results of the "relative effects".

Discussion: the answer to science question 3 needs to be strengthened in the discussion section.

Answer: We added that in the discussion section (L401-403 and L418-441). I further discuss the effects of climate on the relationship between biodiversity and biomass and other possible influences. Please see Discussion 4.3 for details.

Referee #2

This paper analyzes the influence of past and present climate on the contemporary biodiversity pattern of grassland on the Mongolian Plateau. They compare the influence of modern climate (MAT, MAP, Aridity Index) with that of mid-Holocene and Last Glacial Maximum (LGM) climate on contemporary biodiversity. For this purpose, the authors sampled 152 sites on the Mongolian Plateau during field surveys between 2014 and 2018 and determined three categories of biodiversity, i.e., taxonomic, phylogenetic, and functional biodiversity. Furthermore, they simulated the climatic conditions during the mid-Holocene and the LGM. Finally, they used Random Forest and Structural Equation models, They found that both paleoclimate changes and modern climate governed contemporary biodiversity patterns, while community biomass was mainly affected by the modern aridity index.

The paper is well written. The methods for determining the three different biodiversity categories and for analyzing the relationship between past and present climate on the one hand, and biodiversity patterns on the other, appear to be scientifically sound. Overall, the paper adds knowledge to the previously published results of the same group of authors on the effect of humidity on the relationship between species richness and biomass. Therefore, it could be considered for publication in

Biogeosciences. However, there are some specific questions and issues that need to be addressed before the paper becomes acceptable for publication. Those points are specified below.

Specific comments:

L147: How did you define “limited human interference”?

Answer: Firstly, according to the studies of Fang et al. (Fang et al., 2009), the selection of sample sites should follow three principles: 1); The material composition, community structure and habitat within the community were relatively uniform; 2) The community area is enough to allow more than 10-20 m buffer zone around the quadrat; 3) Select relatively uniform slopes on flat or gentle slopes, avoiding hilltops, gullies, or complex terrains, except for communities dependent on specific habitats. Secondly, grazing is the main land use mode in Mongolian plateau steppe. “Limited human interference” mainly refers to the selection of areas with less human activities such as grazing for investigation. Specific indicators include the following aspects: 1) Avoid choosing areas with manure of cattle and sheep; 2) Dominant species such as *Leymus chinensis*, *Stipa spp.* are eaten less by livestock; 3) There were fewer degradation indicators. It mainly refers to the decrease in the number of established species or dominant species in the grassland, while the degeneration indicator plants such as *Convolvulus ammannii*, *Potentilla acaulis*, *Artemisia frigida*, *Stellera chamaejasme* and *Cynanchum hancockianum* appeared in large numbers. For example, in desert steppe, the number of *Stipa breviflora* decreased in overgrazing grassland, while the number of *Convolvulus ammannii* (degradation indicators) increased. We’ve replaced limited human interference with little human interference (L149).

L148: Which criteria were used to decide whether one or three 10 m x 10 m quadrats were set?

Answer: According to the methods and protocols for plant community inventory proposed by Fang et al. (Fang et al., 2009), most vegetation survey in this study was conducted by setting one 10 m x 10 m quadrat at the site. However, in a few areas with sparse vegetation and large heterogeneity, we set three 10 m × 10 m quadrats to ensure the accuracy of the survey data. We supplemented the manuscript (L151-152).

L150: Why only three quadrats at a few sites?

Answer: I’m sorry we didn’t describe it clearly. Five 1 m × 1 m plots were set up in

each corner and center of the quadrat to investigate vegetation, and the species name, height, density and coverage of the 5 plots were recorded. Three 1 m × 1 m plots along the diagonal line were selected from the five plots to measure the standing biomass of each species. Both biomass and biodiversity calculations were based on three plots (L156-157).

L168: Which reference period did you choose for "present-day" climate? 1961-1990? 1981-2010? Or else? Please specify here.

Answer: Current climate data refer to temperature and precipitation averages from 1979 to 2013, which have been supplemented in the manuscript (L162-163).

L169: With simple calculation of temperature or precipitation differences, you get a simple measure of climate change from past to present, but not of climate variability in the period between. This should be made clear here, otherwise the term climate variability is misleading here.

Answer: Thank you very much for your comments. I revised it to change “climate variability” to “climate change” (L173).

L180: Do you really mean median, or mean? In the following sentence you have calculated the mean value of the range (L183).

Answer: I was not making it clear here. This is the mean value of the range. I have modified this (L 183).

L286-293: Please specify contribution of AI, MAT, MAP for each of the four periods because it could be MAT, MAP, AI, or a combination of those.

Answer: Based on the results of the Random Forest model, we identified the climate variables that significantly affected biodiversity and divided them into composite variables. In Fig. 4, both present climate and paleoclimate change are complex variables. Principal component analyses (PCAs) were used for complex variables with multiple predictors. Modern climate is the compound variable of AI and MAT, and the first principal component explains 70.30% of the total variable (Table S2). Paleoclimate change is the compound variable of $AMAT_{mid}$, $AMAT_{lgm}$ and $AMAP_{lgm}$, and the first principal component explains 64.67 of the total variable (Table S2). Fig. 5 shows the full model of the impacts of major climate factors (AI, MAT, $AMAT_{mid}$,

$AMAT_{lgm}$ and $AMAP_{lgm}$) on biodiversity and biomass, with no significant effects of $AMAP_{lgm}$ on biodiversity and productivity (L302-308). So the detailed contribution of each climate factor was not described here (L285-292).

L297-298: Please decide: MAT anomaly or MAT & MAP anomaly.
Answer: Sorry, this is the MAT anomaly from the Middle Holocene to the present, the MAT and MAP anomaly from the Last Glacial Maximum to the present (L297) .

L344: Please cite some key papers.
Answer: I have added references here (L344).

L345: Give a reason why further studies are needed. Should ideally become clear already in the Introduction.
Answer: I have revised this sentence (L344-345). Although a rich body of research has explored the factors affecting biodiversity patterns and their relationships with biomass (Van Der Plas, 2019; Tilman et al., 2012), it is not clear how current climate and paleoclimate together affect the relationship, especially in grassland communities. This is also detailed in the introduction (L78-119).

L355: “and especially climate change”: It is not clear how you assessed or quantified past climate change in the respective region. You had simulated mid-Holocene and LGM climate, but as far as I have understood, no information on the periods in between, i.e., no information on how climate changed in the meantime, was available.
Answer: I’m sorry that I didn’t make it clear. The climate change here mainly refers to the climate anomaly, that is, the change in MAT between LGM and MID and the present (L355). In addition, many studies have used climate anomalies, value of the difference between the paleoclimate and the present climate, as a proxy for the overall magnitude of climate change since a certain period (Wang et al., 2021; Sandel et al., 2011; Nolan et al., 2018).

L355: “Paleoclimate changes filtered”: Same here: how did you assess past climate change? By simple linear interpolation between LGM and mid-Holocene and present-day climate? Please explain.
Answer: This still refers to climate anomaly, which I have modified (L355-356).

L368: Do you mean MAP and temperature here? Otherwise MAT and temperature are repetitive.

Answer: According to Fig. 5, PD was negatively correlated with the present climate (MAT) and temperature anomalies in the Mid-Holocene ($AMAT_{mid}$). I have modified this to prevent ambiguity (L370).

L372-374: This sentence does not really explain the differences between your results for Mongolian grasslands and the literature reports on global forests. Please elaborate.

Answer: We added in the discussion section (L368-L384). The importance of paleoprecipitation variation in shaping the pattern of contemporary phylogenetic diversity in forest ecosystems. Additionally, Quaternary glacial-interglacial climate oscillations led to the extinction of trees in many parts of the globe, for example in Australia (Macphail et al., 1995) and Europe (Svenning, 2003), affecting the PD of global forest ecosystems. The different effects of climate on the phylogenetic diversity of grassland and forest may also be related to the differences in the morphology of herbs and woody plants. For details, see the discussion in lines 368-384.

L375-376: If functional richness was negatively related to LGM climate anomaly, it means that functional richness was decreased more strongly with greater climate anomaly, but then it can't be due to the tolerance of plant traits to past climatic conditions, but due to their intolerance.

Answer: Thank you very much for your suggestion. I quite agree with you and have revised it (L386).

L379: This sentence backs up my statement that there was very likely a reduction of functional diversity in the past.

Answer: Thank you. I'm glad we're on the same page.

L412: Your previous research (Li et al., 2020), where you described the influence of humidity on the relationship between SR and biomass, should also be mentioned in the introduction

Answer: I supplement my previous research in the introduction (L120-L123).

Fig. S1: It would be good to also show the MAT of the current climate, as well as the Aridity Index of mid-Holocene and LGM climate for the sake of consistency.

Answer: Thank you very much for your advice. For the sake of consistency, I have shown the MAT for the current climate, the Mid-Holocene and the LGM in Figure S1. Aridity Index of mid-Holocene and LGM climate are not shown because they are not used in the manuscript (Figure S1).

Technical corrections: see annotated manuscript.

Answer: I have revised the whole manuscript according to the annotation.

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