# Responses and Changes to Reviewers' Comments

**Dear Reviewers,**

We really appreciate your helpful suggestions and comments. We have carefully revised the manuscript and addressed all comments. In terms of content, we mainly increased the experimentation of CRU and ERA5 meteorological data to enhance the reliability of the article results. We also conducted a mechanism analysis to investigate how drought regulates the relationship between vegetation and precipitation (temperature). As for the methodology, we detrended all variables before studying the vegetation-climate relationship to prevent statistical analysis independence. Instead of comparing the NDVI and climate relationship between pre- and post-2000, we used multiple sliding windows to emphasize the inter-annual variability of this relationship. In writing, we improved the language use throughout the entire article, made significant changes to the introduction to highlight the innovation of this study, and added descriptions of the interpretation of the results, as well as discussions of the results.

## Referee: 3

***Major***

**1 The discussion part emphasizes that the human factor is very important, but the draft spent most of the time discussing temperature and precipitation impacts on vegetation. It's better to highlight the key message author wants to convey**

**Response:**

Thank you very much for your suggestions. Considering that the relationship between NDVI and social-economic divers such as GDP and population is very complex that should not be the focus of this study, we removed this part of the content in the article. In the discussion section, we analyzed how drought regulates the relationship between NDVI and precipitation (or temperature) based on two indicators, vapor pressure deficit (VPD) and soil water volume (SWV), and the results with a 13-year sliding window are shown below. We found that the fluctuations in $R_{NDVI-GP}$ and $R_{NDVI-GT}$ coincides closely with the variations in drought conditions. In the areas with the trend in VPD less than 0.02 hpa/yr, where grasslands are predominantly distributed, an increase in SWV tends to cause a decrease in $R_{NDVI-GP}$, but an increase in $R_{NDVI-GT.}$ However, when the VPD trend exceeds 0.02 hPa/yr, a more negative trend in SWV tends to result in more negative trends in both $R_{NDVI-GP}$ and $R_{NDVI-GT}$.

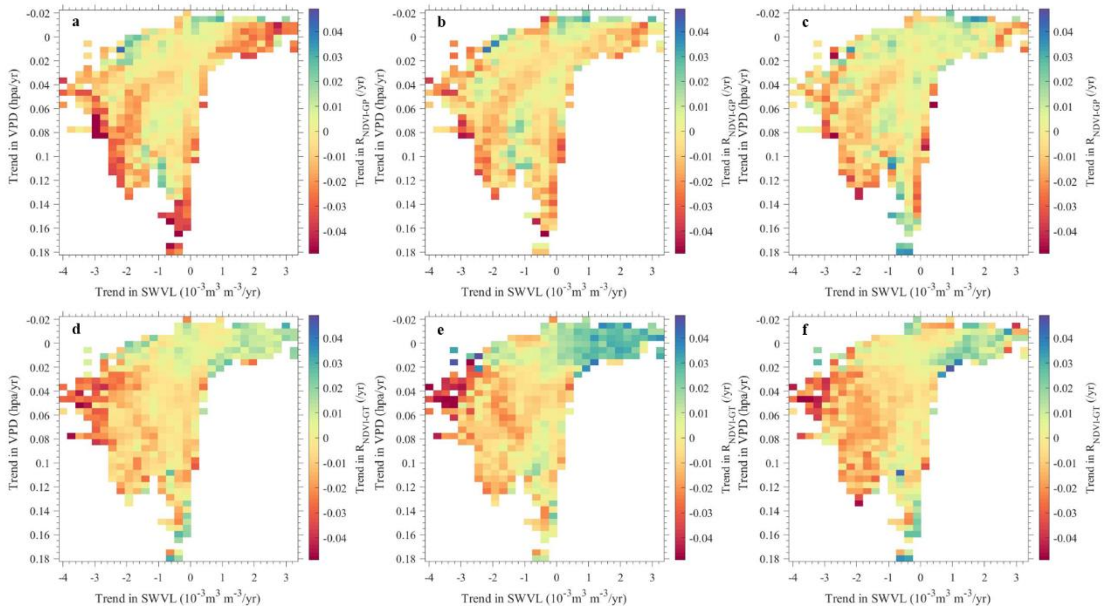


**Figure 6. Average trend of $R_{NDVI\text{-}GP}$ and $R_{NDVI\text{-}GT}$ at a 13-year sliding window in a climate phrase space.** Here, $R_{NDVI\text{-}GP}$ is the partial correlation coefficient between GS NDVI and GS precipitation from Interp (**a**), CRU (**b**), and ERA5 (**c**); $R_{NDVI\text{-}GT}$ is the partial correlation coefficient between GS NDVI and GS temperature from Interp (**d**), CRU (**e**), and ERA5 (**f**). They are calculated using a 13-year sliding window during 1982-2015. All variables are detrended. The climate space is delineated by changes in GS soil water volume (SWV) and changes in vapor pressure deficit (VPD).

**2 The analysis method is not solid. For example, when mentioning significance, I have no idea how to measure it**

**Response:**

Thank you very much for your suggestions. To avoid disagreements, we removed the normalized linear regression analysis and only studied the relationship between NDVI and climate through the partial correlation analysis. The partial correlation coefficient and significance were described in Methodology and shown below.

The calculation of the partial correlation coefficient is shown in formula (5) (Baba et al., 2004).

$$\boldsymbol{R}_{x_j y} = \frac{-c_{jy}}{\sqrt{c_{jj}c_{yy}}} \tag{5}$$

where $\boldsymbol{R}_{x_j y}$ is the partial correlation coefficient between the $j$th independent variable and the dependent variable $y$, $c$ is the corresponding element in the inverse matrix of the correlation coefficient matrix. The statistical significance of the partial correlations was calculated using the t-test shown in formula(6) (Song and Ma, 2011) with the significance level set to 0.05:

$$t_{xy,z} = \frac{r_{xy,z}}{\sqrt{1-r_{xy,z}^2}}\sqrt{n-m-1}. \tag{6}$$

Here, $m$ is the number of independent variables and $n$ is the number of samples.

**3 All results have no quantitative description but only a qualitative description**

**Response:**

Thank you very much for your comments. We have added quantitative description that interpret our results, for example, this paragraph for the results below: "The statistics categorized by vegetation types show that, $R_{NDVI-GP}$ and $R_{NDVI-GT}$ have shown a declining trend in approximately 81% and 71% of the entire forest area in northwest China, respectively. In the grassland, $R_{NDVI-GP}$ exhibits almost an equal distribution area between positive and negative trends in terms of area, whereas $R_{NDVI-GT}$ displays an upward trend in the majority of the area, accounting for approximately 56%. As for the barren land, the areas occupied by the positive and negative trends of $R_{NDVI-GP}$ or $R_{NDVI-GT}$ are roughly equal."

**4 There is no discussion behind the results**

**Response:**

Thank you very much for your comments. We added a discussion behind the results. Firstly, We conducted a mechanism analysis to investigate how drought regulates the relationship between vegetation and precipitation (temperature), and the results are shown below.

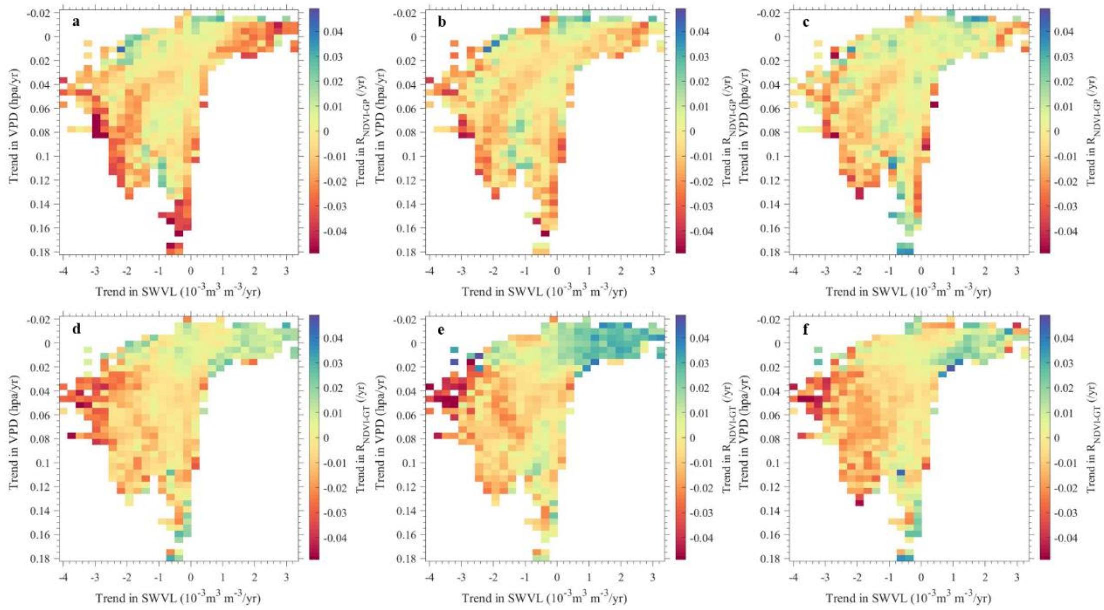


**Figure 6. Average trend of $R_{NDVI-GP}$ and $R_{NDVI-GT}$ at a 13-year sliding window in a climate phrase space.** Here, $R_{NDVI-GP}$ is the partial correlation coefficient between GS NDVI and GS precipitation from Interp (**a**), CRU (**b**), and ERA5 (**c**); $R_{NDVI-GT}$ is the partial correlation coefficient between GS NDVI and GS temperature from Interp (**d**), CRU (**e**), and ERA5 (**f**). They are calculated using a 13-year sliding window during 1982-2015. All variables are detrended. The climate space is delineated by changes in GS soil water volume (SWV) and changes in vapor pressure deficit (VPD).

In addition, we performed quadratic curve fitting of $R_{NDVI-GT}$ and time for different vegetation types (shown below), confirming the hypothesis that the impact of rising temperature on the current enhanced greening trend will decline or even disappear

(Piao et al., 2006). We found the forest in northwest China reaches its maximum value of $R_{NDVI-GT}$ earlier than grassland and barren land, suggesting that the decline in the relationship between forest and temperature occurs earlier than it does for grassland and barren land

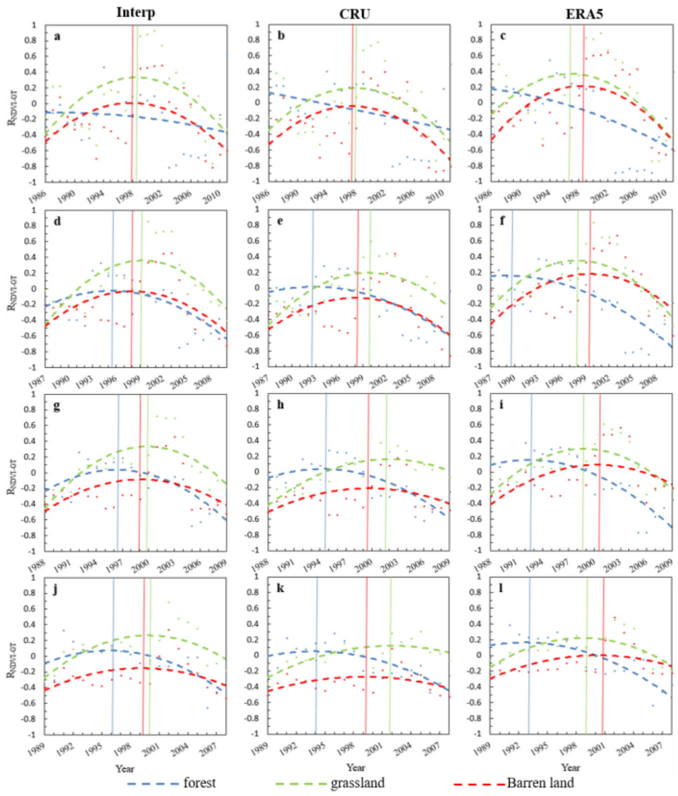


**Figure 7. Annual variations and quadratic fitting trend lines of $R_{NDVI-GT}$ for different vegetation types.** Here $R_{NDVI-GT}$ is the partial correlation coefficient between GS NDVI and GS temperature. All variables are detrended. Three types of climate data (Interp, CRU and ERA5) are used, corresponding to three columns. The first to fourth lines correspond to the sliding windows of 9years, 11years, 13years and 15years respectively. Dashed lines represent the quadratic curves, while solid lines represent the central lines of quadratic curves.

***Minor***

**The landcover map is not given, it can be added to Figure 1. Also. There may be problems with the NDVI of the bare land**

**Response:**

Thank you very much for your comments. We added a landcover map in Figure1. The areas with an average annual NDVI of less than 0.1 were removed from the analysis (Chen et al., 2018; Piao et al., 2005). Due to the NDVI mask processing, barren land can also be understood as sparsely vegetated areas.

**How to synthesize MODIS (2000-2019) and GIMMS (1982-2015)? It is not stated clearly in the method section**

**Line 80: MODIS NDVI from 2000-2019 and GIMMS NDVI from 1982-2015, but this sentence is not clear**

**What are the advantages and disadvantages of using MODIS and GIMMS in studying the response of vegetation to climate change in these areas? Please provide some references**

**Response:**

Thank you very much for your comments. To avoid errors caused by combining different datasets, we are currently only using the GIMMS NDVI for our research

**Figure 5 and Figure 6 are hard to read, and simplifying them will be better**

**Response:**

Thank you very much for your comments. We removed the content of normalized linear regression analysis in the article

**Fig11 f, y-axis mislabeled**

**Fig12 How to derive GDP in no man's land (e.g., areas in northern Xinjiang)**

**Response:**

Thank you very much for your comments. Considering that the relationship between NDVI and social-economic divers such as GDP and population is very complex that should not be the focus of this study, we removed this part of the content in the article.

**In all figures, how to define no data areas? If you masked NDVI below a certain threshold, please note them in the figure and method**

**Response:**

Thank you very much for your comments. We defined no data areas as the parts with NDVI<0.1. We have noted the no data areas in both figure and method

**Line 85: Please provide the source link; this is not the source from which GIMMS is.**

**Response:**

Thank you very much for your comments. We have provided the source link in the parts of data description

**Line 89: there should be a citation for the MVC method**

Thank you very much for your comments. We added a citation for the MVC method

**Lines 114 and 124: please cite the original author**

Thank you very much for your comments. We have corrected them in the article

**Do not add transparency to the color of the figure4. It is better to set the alpha value to 1, and the leftmost triangle and rectangle of the color bar are separated.**

Thank you very much for your comments. We have corrected them in the article

**Line 194-196: rephrase and it is hard to understand**

**Line 241-243: delete this sentence.**

Thank you very much for your comments. We have rewritten these parts in results

**Line 274: how to calculate significance**

The statistical significance of the partial correlations was calculated using the t-test shown in formula(6) (Song and Ma, 2011) with the significance level set to 0.05:

$$t_{xy,z} = \frac{r_{xy,z}}{\sqrt{1-r_{xy,z}^2}}\sqrt{n-m-1}. \quad (6)$$

Here, $m$ is the number of independent variables and $n$ is the number of samples