

Reply to Referee 2 (Prof. Dr. Xuhui Lee)

We are grateful to Prof. Dr. Xuhui Lee for the encouraging comments and careful reviews which helped to improve the quality of our paper. In the following we quoted each review question in the square brackets and added our response after each paragraph.

[The authors of this paper propose that meteorological conditions on the Tibetan Plateau are partly responsible for the deteriorating air quality in eastern China. They found a robust correlation between wintertime visibility in eastern China with the heating rate (Q1) on the plateau derived from a reanalysis model. An air quality model was used to attribute changes in air quality to emission changes and to changes in meteorology. They found that during years of negative Q1 anomalies, the surface wind was weakened, the air in the boundary layer became more stable, and more moisture was transported from the ocean. All these factors contributed to unfavorable dispersion conditions. I support publication of the paper in ACP.]

Reply 1: Thank you for the encouraging comments

[The current manuscript style is not suited for the readership of ACP. Because literature review is mixed with methods, results and discussion, it is difficult to determine which statements describe past research by other people and which describe new results from this study. They should restructure the manuscript according to the standard template used by a technical journal, by separating the information clearly into different sections (introduction/literature review, methods, results, discussion, conclusions). Data and sources should be clearly explained. Model scenarios and their rationale should also be explained in the methods section.]

Reply 2: Following the comments, the revised manuscript has been restructured based on the original manuscript with the following outline:

1 Introduction

In this Sect., we present all the literature review with moving the descriptions of past research from the original Sect. 4 (please see lines 120-130 in the revised manuscript with track changes) and removed the new results and analysis from this study, as a part of results and discussion, to Sect. 3.1 (Contributions of pollutant emissions and climate change to interannual haze variations in China).

2 Data and methods

In this Sect., the design of sensitivity simulation is moved from the original Sect. 6 (please see lines 193-202 in the revised manuscript with track changes).

3 Results and discussion

3.1 Contributions of pollutant emissions and climate change to interannual haze variations in China

This Sect. is built with the sentences of the original introduction .

3.2 A climatological “susceptible region” for haze formation in China

3.3 Relationships between TP’s thermal forcing and haze over CEC

we removed the literature review to lines 120-130 (in the revised manuscript with track changes) in Sect. 1 (Introduction).

3.4 The TP-warming inducing favorable meteorology for CEC’s haze

3.5 A sensitivity simulation experiment on effect of the TP-warming

The design of sensitivity simulation is moved to lines 193-202 (in the revised manuscript with track changes) in the Sect. 2(Data and methods).

4 Conclusions

[The first name of all the authors should be spelled out completely. It is very difficult to distinguish Chinese names, and using initials only makes the job even more difficult.]

Reply 3: We have checked that the first names of all the authors were spelled out completely in our submitted PDF-file of manuscript, and after the submission the ACP changed them to the initials for the ACP discussion.

[Quality of the graphs should be improved. Some legends and axis labels are too small or too faint.]

Reply 4: We are sorry for the poor figure quality. All the Figures have been redrawn with high quality for ACP-publication (Please see the new Figs. In the revised manuscript).

[I understand that the authors have plan to continue to elucidate mechanisms underlying the Q1-air quality “teleconnection”. Here I present several questions that arose from my reading of the manuscript. They do not need a response at this time but may be helpful to the authors in their future research:

1) Q1 is a quantity derived from atmospheric reanalysis. Given that meteorological observations are sparse on the Tibetan Plateau, I wonder how robust this quantity is. The current research relies solely on one reanalysis product (NCEP?). Do other reanalyses show similar Q1 variabilities (both inter-annual and long-term trend)?

2) It has been known for some time that the eastern Asian monsoon has been weakening in the past three decades. As far as I know, there is no accepted theory for explaining why this is occurring. This study presents empirical evidence suggesting that the weakening trend is tied to changes in land cover on the plateau, as implicated by the strong correlation between Q1 and wind. In this regard, two questions are worth pursuing: a) what types of change on the surface (snow albedo change, glacier melt, desertification, shrinking of shrub land, etc) are responsible for the changing Q1 signal in the atmosphere? d) How do you test the TP hypothesis versus other competing hypotheses regarding the monsoon trend?

3) Related to my point 2 above, the author suggests that higher Q1 values are caused by contamination of snow cover by pollutants transported to the plateau, due to the fact that dirtier snow absorbs more solar energy. Can you find direct evidence for a declining trend in the snow albedo? If this proves true, the snow albedo effect constitutes a positive feedback on air quality at the regional scale, which may have contributed to the observed decline in visibility. However, the feedback mechanism cannot explain the large year-to-year variabilities in Q1. It is intriguing

that Q1 and air quality are correlated both in terms of the decadal trend and in terms of interannual variabilities. Why does Q1 change rapidly from one year to the next?]

Reply 4: Your constructive suggestions are greatly appreciated and very helpful for our further study. In this preliminary study based on long-term observational data and a sensitivity simulation experiment, we investigate a relationship between the haze pollution in China and TP's environment and climate changes. It should be emphasized that considering the quality of reanalysis data over and around the TP, a comparison between NCEP/NCAR and other reanalysis data sets such as JRA-25, ERA-Interim, or MERRA is necessary in further work. The understandings of TP's thermal forcing changes and East Asian monsoon declines are challenging topics. The impacts of TP's climate change on air quality in China could be further studied on the shifts in weather patterns, pollutant emissions, depositions and chemical reactions in the atmosphere to comprehensively understand the meteorological drivers of air quality in a changing climate and also to consider the ocean-related impacts of climate change.

We have accordingly added the above discussions at the end of Sect. 4 (lines 402-410 of Conclusions in revised manuscript with track changes).