The manuscript by Gao et al. studies the climate responses to emission reductions in air pollutants over China due to clean air actions from 2013 to 2017, investigates both aerosols and ozone changes and their climate impacts by conducting several experiments using CESM2 model. The topic has wide implication for emission reduction policy decision making over China and fits the scope of the general ACP readership. This paper is overall well written, but there are several issues need to be addressed before the manuscript can be accepted for publication.

We thank the reviewer for the constructive suggestions, which are very helpful for improving the clarity and reliability of the manuscript. Please see our point-by-point responses (in blue) to your comments below.

Major:

1. The model results significantly underestimate the PM2.5 decrease compared with observation （Fig.2）, which contributes to the uncertainty of this study. It would be interesting to quantify to what extent the model bias influences the estimated climate impacts.

Thank you for the suggestion. The model significantly underestimates the $PM_{2.5}$ decrease in China during 2013–2017, which is caused by many factors including strong aerosol wet removal, uncertainties in new particle formation, coarse model resolution in global climate models, the uncertainty of anthropogenic emissions of aerosols and precursor gases, the treatments of meteorology and aerosol processes, which have been reported in many previous studies (Yang et al., 2017a, b; Zeng et al., 2021; Ren et al., 2021; Fan et al., 2022, 2018). The low bias in estimated aerosol decreases may result in an underestimation of the simulated climate responses in CAM6. We have added these descriptions in the discussion section.

2. The authors investigated the climate response by conducting simulations with fixed SST at the climatological mean. I wonder how much does the slow and fast response contribute to the total climate response respectively? Though the authors stated that they will revisit this issue using a fully coupled model configuration with both fast and slow climate responses included in future studies, it is suggested to discuss the uncertainties due to neglecting the slow climate response in this paper.

Firstly, only fast climate responses are considered in our study, while the emission reductions could also influence climate response through slow oceanic processes and air-sea interactions, which can be improved by conducting fully coupled atmosphere-ocean simulations in future studies. Samset et al. (2016) showed that the fast precipitation response to changes in aerosols dominated the slow oceanic response over land of East Asia. However, to what extent the fast processes contributed to the temperature response needs further study. Neglecting the slow climate response here could lead to an incomplete aerosol climate effect.

3. I would suggest the authors to provide an in-depth discussion in the discussion section on these uncertainties, including the model bias, the neglect of slow response, the neglect of nitrate and ammonium, etc. It is better to have error bars on the simulated results or at least discuss the possible bias ranges. In addition, as stated in L215, different chemical and physical schemes contribute some uncertainties, leading to the differences compared to previous studies. Thus it is better to list the specific parameterizations of different models in Table S3.

We have substantially revised the discussion section as the following:

There are some limitations and uncertainties in the study. Firstly, only fast climate responses are considered in our study, while the emission reductions could also influence climate response through slow oceanic processes and air-sea interactions, which can be improved by conducting fully coupled atmosphere-ocean simulations in

future studies. Samset et al. (2016) showed that the fast precipitation response to changes in aerosols dominated the slow oceanic response over land of East Asia. However, to what extent the fast processes contributed to the temperature response needs further study. Neglecting the slow climate response here could lead to an incomplete aerosol climate effect. Secondly, the model significantly underestimates the $PM_{2.5}$ decrease in China during 2013–2017, which is caused by many factors including strong aerosol wet removal, uncertainties in new particle formation, the coarse model resolution, and the uncertainty in anthropogenic emissions of aerosols and precursor gases (Yang et al., 2017a, b; Zeng et al., 2021; Ren et al., 2021; Fan et al., 2022, 2018). The low bias in estimated aerosol decreases may result in an underestimation of the simulated climate responses in CAM6. Thirdly, nitrate and ammonium aerosols, which are not treated in current version of CESM2, also changed from 2013 to 2017 (Xu et al., 2019) and should have impacted on climate, although nitrate concentration in Beijing changed slightly during this time (Zhang et al., 2020). Fourthly, only 20-year simulations were performed in this study, longer simulations with ensemble members may present a more robust result. Finally, only one model is used in our study, a potential model dependence of climate responses to aerosol reductions needs further investigation using multi-model ensemble simulations.

We have also added error bars in Figure 7 and uncertainty range in Table S2.

CAM6 (CESM2) and CAM5 (CESM1) are climate models with simulation of major aerosol species, while GEOS-Chem is a chemical transport model with simulation of ozone and aerosols driven by meteorological fields from reanalysis. GEOS-Chem (http://www.geos-chem.org) is a global 3-D model of atmospheric chemistry driven by meteorological input from the Goddard Earth Observing System (GEOS). The detailed information about chemistry, aerosol process, transport, deposition, and radiation in GEOS-Chem is available at https://geos-chem.seas.harvard.edu/. CESM2/CESM1 (https://www.cesm.ucar.edu) is the coupled climate/Earth system models developed by the National Center for Atmospheric Research (NCAR). Its atmosphere model is the Community Atmosphere Model Version 6/5 (CAM6/CAM5). The detail information about chemical and physical schemes and the changes between CAM5 and CAM6 are available in Danabasoglu et al. (2020). We have added these descriptions in Table S3.

Minor:

1. L79, 'A comprehensive consideration of aerosol/O3-radiation and aerosol-cloud interactions are included in the model.' How are these processes considered specifically in the model? I suggest authors to introduce these schemes in detail, or at least show some references.

In CESM2-CAM6, aerosols are treated using the Modal Aerosol Model version 4 (MAM4; Liu et al., 2016). The Morrison-Gettelman cloud microphysics scheme version 2 (MG2, Gettelman and Morrison, 2015) is applied to forecast mass and number concentrations of rain and snow. The mixed phase ice nucleation depending on aerosols is also included (Hoose et al., 2010; Wang et al., 2014). Radiation transfer scheme uses Rapid Radiative Transfer Model for General circulation models (RRTMG, Iacono et al., 2008). Ozone mixing ratio is prescribed for use in radiative transfer calculations. We have added this information in the manuscript.

2. L83, it is better to list some reference about ozone simulation in GEOS-Chem here.

We have added more information and references for GEOS-Chem simulation as "Global three-dimensional tropospheric monthly O_3 concentrations below 450 hPa for years 2013 and 2017 are adopted from simulations using GEOS-Chem model v12.9.3, considering that it has a good performance in simulating ozone concentration changes during 2013–2017 (Li et al., 2019a, b, 2021). GEOS-Chem is a global model of atmospheric chemistry with fully coupled O_3–NO_x–hydrocarbon–aerosol chemical mechanisms, which has a horizontal resolution of

2° latitude × 2.5° longitude and 47 vertical layers driven by the MERRA-2 (Modern-Era Retrospective analysis for Research and Applications Version 2) meteorological fields. The model simulations in 2013 and 2017 with one-year spin up use the same aerosol and precursor gas emissions as used in CAM6 and the results are interpolated to the same resolution used in CAM6. The details of the GEOS-Chem model simulations can be found in Li et al. (2022) and Yang et al. (2022). Note that, GEOS-Chem model presents a strong decrease in O_3 concentrations in upper troposphere between 2013 and 2017, which is mainly attributed to the varying meteorological fields between 2013 and 2017. To minimize the impacts from the changes in meteorology, only O_3 data below 450 hPa from GEOS-Chem are used in CESM2 simulations, while keeping O_3 above 450 hPa unchanged, and are implemented by cycling the one-year data as monthly climatological mean."

3. In section 2, please add some introductions about observations used in this study.

We have added the sentence: "Hourly observations of $PM_{2.5}$ and O_3 concentrations across China in 2013 and 2017 derived from the China National Environmental Monitoring Centre (CNEMC) are applied to evaluate the model performance." in section 2.

4. L133, change 'other sub-regions' to 'over other sub-regions'.

Changed.

5. L136-L137, better to list some references here.

Added the reference (Li et al., 2019).

6. Figure 1, better to mention the MEIC inventory in figure caption.

We have added the sentence: "The anthropogenic emission data are derived from MEIC." in figure 1 caption.

7. Figure S1, the color bar is not shown.

Revised.

Reference:

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