

Atmos. Chem. Phys. Discuss., referee comment RC1
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Comment on acp-2022-526

Anonymous Referee #1

Referee comment on "Modulation of daily PM_{2.5} concentrations over China in winter by large-scale circulation and climate change" by Zixuan Jia et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-526-RC1>, 2022

This study focused on the relationship between large-scale circulation patterns and daily PM_{2.5} concentrations, and their sensitivity to emissions in YRD over 1999–2019 based on UKESM1 model. The authors constructed an index and projected future changes in PM_{2.5} under SSP3-7.0 scenario and found the effect of climate change would partly offset that of emissions. The manuscript was well-written and properly organized, which was within the scope of ACP. However, there are also some major issues that have to be addressed before it can be considered for publication. Please see my detailed comments below.

General comments:

1. The results of this study are primarily based on UKESM1 model simulations. Although the authors compared the modeled PM_{2.5} concentrations with those from CAQRA reanalysis data, they have not verified whether the model could well reproduce the circulation conditions during the polluted days. The modeled PM_{2.5} only covers 20 years and the nationwide PM_{2.5} observations have already had 10-year data. Comparing the model simulation and observations in term of large-scale circulation and the index defined can give a more robust conclusion.

2. The future predictions of climate change impact of PM_{2.5} is investigated in this study based on changes in meteorological fields under SSP3-7.0 pathway. First of all, SSP3-7.0 is not a representative scenario for future air quality or climate change, at least in China. The scenario assumes the anthropogenic emissions of air pollutants continue to increase for a long time after 2015, but the emissions in China have significantly reduced since 2010s, which largely affect regional climate and cause the inaccurate of regional climate under SSP3-7.0. Also, China has committed to achieve carbon neutrality in 2060 and the results under the low forcing scenarios should be considered or discussed.

3. In addition, for the future predictions, how is the UKESM1 performed compared to other climate models in CMIP6. Different models tend to predict different regional circulation

response. Does the conclusion that “a weaker pressure gradient between the Siberian High and the Maritime Continent Low” also exist in other CMIP6 models?

Specific comments:

1. Many studies have examined the circulation pattern and regional transport of air pollution over eastern China from the past to the future and they have similar or different conclusions. For example, Ren et al. (2021) quantified the sources of PM_{2.5} in many subregions of China and they found that PM_{2.5} pollution in eastern China is dominated by local emissions using an aerosol source tagging technique in an aerosol-climate model. Yang et al. (2021) examined the atmospheric circulation patterns conducive to severe haze in eastern China based on observations, modeling results and CMIP6 future predictions. They found that during the extreme pollution month the PM_{2.5} was mainly from aerosol transport from the North China Plain, although they also reported a future increase in the atmospheric circulation pattern conducive to the pollution under high forcing scenarios. Li et al. (2022) also highlighted the importance of climate change in regulating future air quality. They found that climate-driven aerosol changes are comparable to those contributed by changes in emissions over many regions of the world in high forcing scenarios. The authors are suggested to compare their results with previous studies.

2. Why only SSP3-7.0 scenario is selected?

3. Will the lack of SOA affect the conclusion, since that the circulation pattern is accompanied by temperature/relative humidity changes, affecting the formation of aerosols?

4. I noticed the authors have published a very similar paper in ACP using observations (Jia et al., 2022). They should clarify the new scientific findings in this study rather than the data used (model results and observations). The index defined in this study is not the same as Jia et al. (2022). Does that mean the model and observations will draw different results?

5. There are many uncertainties in this studies that should be discussed. I strongly recommend the authors to add a discussion section. For example, the model has biases in reproducing mean aerosol concentrations and the correlation coefficients reported in this study are not high enough. These may influence the results. The

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