Comment on acp-2021-328

Anonymous Referee #1

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Referee comment on "Aerosol transport pathways and source attribution in China during the COVID-19 outbreak" by Lili Ren et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-328-RC1, 2021

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Review of „Aerosol transport pathways and source attribution in China during the COVID-19 outbreak" by Ren et al

Ren et al. assess the contributions from local emissions and transport to PM2.5 concentrations in Chinese regions during three periods when COVID-19 affected the socio-economic activity of the country at the beginning of 2020. In principle, the topic is interesting and relevant, but I have major reservations concerning the chosen methods and the documentation thereof as well as the interpretation and discussion of the results.

The finding of regionally increasing PM2.5 during the COVID-19 period is in light of lockdowns counterintuitive and needs a clearer discussion in the text. The authors state that it is due to transport from outside of China, but the quantified 4-10% of PM2.5 transport into a Chinese region for polluted days and even the largest 40-66% regional contributions from transport during the lockdown, when local emission should be small, are no particularly convincing evidences, especially in light of the known poor model performance for PM2.5 indicated by the authors. The results need a more compelling interpretation, making better use of the knowledge of the impact of the meteorological conditions on PM2.5, e.g., through a discussion in light of other studies. It would be useful to have a discussion section separate from the conclusions. This would allow to fully appreciate the limits and advances of this work compared to previous studies, and draw a clear and concise conclusion from this work. I give more details in my specific comments that I hope will be useful for improving the manuscript.

Specific comments

- L. 51: „in December 2019" - give the time period of the outbreak in China
- L. 53-54: I recommend removing „was the first country" from the sentence since it is

not
- relevant for the scientific content, but say instead when the measures began and ended since this is indeed relevant for the interpretation of your findings.
- L. 62-63: revise sentence for clarity
- L. 66: „change" -> changes
- L. 80-83: when did the haze occur? Does your simulation reproduce this event?
- L. 114-116: If there are studies already, what does your work add to the previous knowledge?
- L. 146: How many simulations did you perform over what time period?
- L. 150-151: There should be an argument why emissions from SSP2-4.5 are used here, even though more recent global emission data has been created (e.g., Lamboll et al., 2020)
- L. 157-160: How were these emission estimates created? Please illustrate the results for the emissions and compare them to other new emission data. What is meant by „remaining reductions"?
- L. 166: „from April 2019 to March 2020 repeatedly for six years" this needs more words to explain what you did. How did you do for instance the initialisation? What is meant by repreating the simulation for six years?
- L. 169: It would be more relevant to say which weeks had the most severe lockdowns and use this information to interpret the results.
- L. 191: What motivates the choice of these regions?
- L. 198-201: Were these nudged simulations to MERRA-2 as well? Than say so. Otherwise it would be useful to say a few words on the performance of MERRA-2 over China as well.
- L. 212: I appreciate and encourage the open communication of uncertainties in modeling. A 50% underestimation of PM2.5 is large. Given your focus on PM2.5 in this study, how can you nevertheless trust the simulation, especially taking into account that nitrate and ammonium are known to be poorly represented in the same model (L. 217)? You revisit this point in the last paragraph of the conclusions, but I also missed guidance for the concrete implication of it there.
- L. 227: State here the three time periods and motivate this choice.
- L. 230 - 236: Say relative to what you make the comparisons.
- L. 368: It would be helpful to state the date in the text, here and/or earlier.
- L. 273-374: 4-10% transport from outside of China on the most polluted day means that local emissions dominate. Maybe explicitly add the implication of your findings.

- Arrange the order of all figures following the order of references to them in the text.
- Figure 1: What time period is meant here?
- Figure 2: What do the colors mean?
- Table 1: State the dates of the weeks.