Dear Editors and Referees:

Thank you very much for your careful review and constructive comments on our manuscript acp-2021-709R. We have accordingly made the revisions. The revised portions are highlighted in the revised manuscript. In the following, we quoted the suggestion for revision in the square brackets and added our response after the suggestion.

Responses to Referee #3

*[**Comments:** The authors have addressed most of my concerns with additional analysis and discussions. The majority of the authors' response somehow admitted the uncertainties or even biases introduced by the method and representativeness of the observational sites. For instance, the unresolvable roles of emission variations of primary aerosol, gas precursors, and chemical transformations. I do think that the uncertainties and the validity of their argument ought to be clearly demonstrated. After these minor corrections, I would recommend its publication on Atmospheric Chemistry and Physics.]*

Response: Thanks for the referee's encouraging comments and helpful suggestions. We have clarified that the emission reductions of primary aerosols and gaseous precursors dominate the $PM_{2.5}$ decline, and the decreasing emissions of gaseous precursors drove enhancing the chemical transformation of NO_2 and SO_2 efficiently to secondary $PM_{2.5}$, which might offset the effect of emission reduction on $PM_{2.5}$ decline. To better demonstrate our results, we have added the according discussions in the revised manuscript (lines 318–331 and lines 423–425) as follows:

The decreasing emissions of gaseous precursors drove faster oxidation of NO_2 and SO_2 to nitrate

and sulfate components of $PM_{2.5}$ in the source regions of air pollution in China (Zhai et al., 2021; Huang et al., 2021). This study identified the enhancing contribution of gaseous precursors to $PM_{2.5}$ concentrations with reducing anthropogenic emissions of air pollutants over the receptor region in regional $PM_{2.5}$ transport.

There are a few sources of uncertainty in the discussion of chemical transformation, for example in the separation of emission- and meteorology-related long-term components and in the selection of observational sites. Our results point to better understand the offsetting effect of SO_2 and NO_2 oxidized to secondary particles on $PM_{2.5}$ mitigation during the emission reduction in the THB … … … …Further work with long-term observational data of $PM_{2.5}$ components like black and organic carbon could be conducted to quantify the influence of emissions of primary components and chemical transformation of gaseous precursors on $PM_{2.5}$ changes. (lines 318–331)

We took considered the uncertainties induced by statistical methods as systematic biases and explained the offsetting effect of enhancing oxidation of gaseous precursors to secondary particles on $PM_{2.5}$ decline during the stringent emission controls. (lines 423–425)

References:

Huang, X., Ding, A., Gao, J., Zheng, B., Zhou, D., Qi, X., Tang, R., Wang, J., Ren, C., and Nie, W.: Enhanced secondary pollution offset reduction of primary emissions during COVID-19 lockdown in China, National Science Review, 8, nwaa137, 2021.

Zhai, S., Jacob, D. J., Wang, X., Liu, Z., Wen, T., Shah, V., Li, K., Moch, J. M., Bates, K. H., and Song, S.: Control of particulate nitrate air pollution in China, Nature Geoscience, 14, 389-395, 2021.