Response to comments of referee #2

General comments

This manuscript uses Gaussian process emulation to generate a efficient surrogate for WRF-Chem to perform the sensitivity analysis of PM2.5 and O3 to sources, and to provide air pollution mitigation suggestions. The combination of WRF-Chem with Gaussian process emulation is novel to reduce computational complexity for sensitivity analysis. The results, especially the joint control suggestions for PM2.5 and O3, are useful in terms of air pollution control. The manuscript is well written, but some parts of it are not clear enough. I would recommend for publication after the authors address the following specific comments:

Many thanks to the reviewer for the comments and suggestions. We have improved the manuscript accordingly. Please find a point-by-point response below.

Specific comments:

1) Line 45: please add references for this statement: Menon, S., Hansen, J., Nazarenko, L. and Luo, Y., 2002. Climate effects of black carbon aerosols in China and India. Science, 297(5590), pp.2250-2253. Gao, M., Sherman, P., Song, S., Yu, Y., Wu, Z. and McElroy, M.B., 2019. Seasonal prediction of Indian wintertime aerosol pollution using the ocean memory effect. Science advances, 5(7), p.eaav4157.

Thanks for the useful references. We have added these references (Menon et al., 2002;Gao et al., 2019) as suggested.

2) Line 81: Is it possible to provide a clear definition of pollutant response surface?

We have added a description of pollutant response surface in the introduction, as shown below.

"The response surfaces describe that how the pollutants, i.e., $PM_{2.5}$ and O_3, will respond to the changes in emissions from different sectors."

3) Line 130-132: This statement is a bit general. Better to use measurements of precipitation and clouds to show this point.

There is no precipitation in Delhi during the simulation period. We have added this statement in the revised version. The climatic averaged monthly precipitation during May in Delhi is only about 20 mm (https://weather-and-climate.com/average-monthly-precipitation-Rainfall,New-Delhi,India).

4) Fig. 6: Better to provide similar plots for other important species, such as organics, SO2, etc.

We have added similar plots for black carbon, non-methane VOC, organic carbon and SO_2 in Figure S13, as shown below.

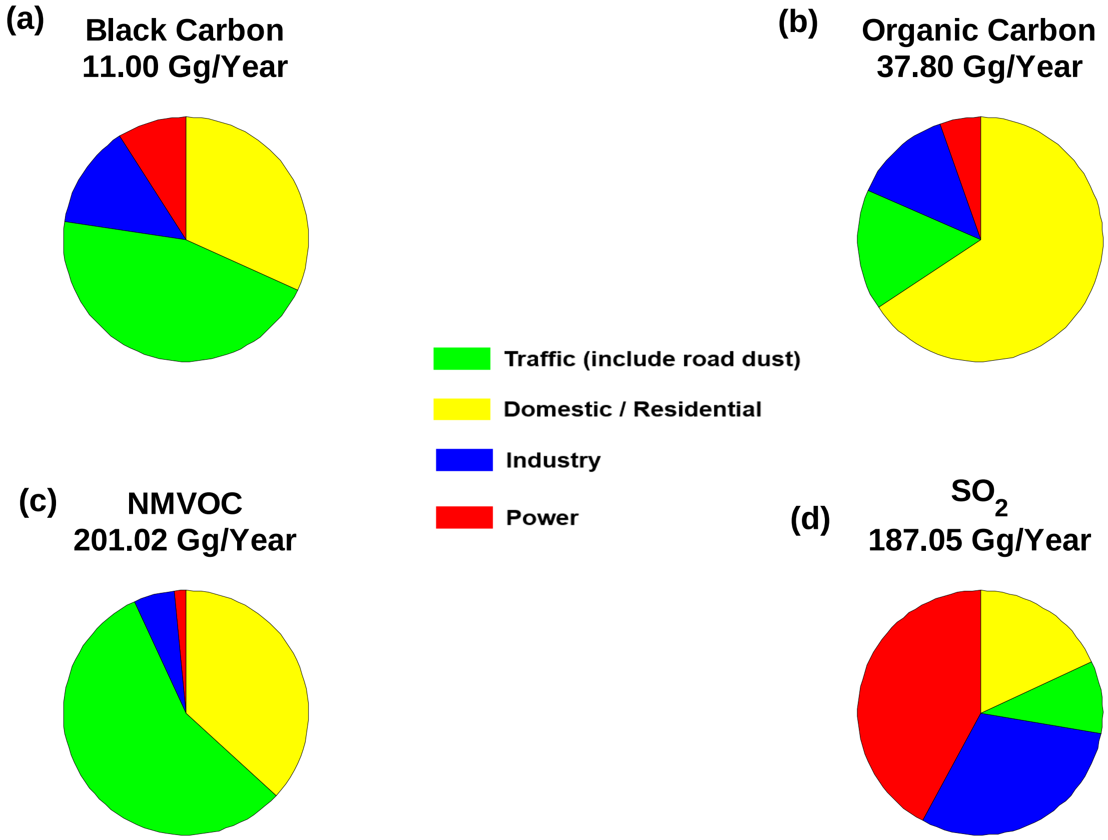

Figure S13. *Annual emission of different sectors in Delhi from SAFAR inventory. (a) black carbon; (b) organic carbon; (c) non-methane VOC and (d) SO_2.*

5) Sect 4: It would be better to compare the results with other similar studies and explain the similarities and differences.

Thanks for the suggestion. We have revised the corresponding context in Section 4 to include a comparison with other similar studies. The revised version is shown below, please also see the change-tracked file for more details.

"They co-dominate the O_3 peak and $PM_{2.5}$ in Delhi during daytime, while the regional transport governs $PM_{2.5}$ during the night, in line with a recent study showing that ~60% of $PM_{2.5}$ in Delhi originates from outside (Amann et al., 2017). Controlling local traffic emissions in Delhi would have the notable side effect of increasing O_3, at least in the pre-monsoon/summer period (peak O_3 season) that we consider here. This is in line with recent increases in O_3 seen in China (Silver et al., 2018;Li et al., 2018). The Chinese experience suggests that regional joint coordination is required to effectively mitigate PM2.5 pollution in Beijing (Liu et al., 2016). Our pollutant response surfaces go one step further and suggest that joint coordinated emission controls with the NCR region surrounding Delhi would be required to not only achieve a more ambitious reduction of $PM_{2.5}$ but also to minimize the risk of O_3 increases."

References:

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Gao, M., Sherman, P., Song, S., Yu, Y., Wu, Z., and McElroy, M. B.: Seasonal prediction of Indian wintertime aerosol pollution using the ocean memory effect, Science Advances, 5, eaav4157, 10.1126/sciadv.aav4157, 2019.

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