

Interactive comment on “Sensitivities of UK PM_{2.5} concentrations to emissions reductions” by M. Vieno et al.

Anonymous Referee #1

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The manuscript by Vieno et al. evaluates the changes in PM_{2.5} concentrations in the UK in response to domestic emissions reductions in 2010, and also evaluates the response for emissions reductions in 2030. The general scope and subject of this study are suitable for ACP, and this work presents some interesting and valuable conclusions for air quality management. Overall, the article was fairly clearly written and easy to follow; the setup and experiments are rather simple. However, there are some very notable gaps in the modeling and interpretation, most obviously that secondary organic aerosol doesn't seem to be treated at all, nor is its omission even ever considered as a source of uncertainty. This is potentially important, as SOA can contribute significantly to PM_{2.5}, and even SOA formed from biogenic hydrocarbons can be sensitivity to anthropogenic emissions of SO₂ and NO_x. In other areas, the analysis seems a bit thin,

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with not much provided in terms of explanations of the underlying chemical processes, nor was an impressive amount of effort put forth to be very thorough or quantitative. Details of these comments are provided below, and I believe the manuscript would be publishable after they are addressed.

MAJOR COMMENTS (order of appearance, not importance):

General: This study focuses on changes in PM_{2.5} from emissions changes, but climate change itself may have an effect. Granted, the latter effect is usually found to be smaller, but it is probably worth mentioning the relevant lit on the topic.

20885.13: Please explain more the details of how observations are used to derive boundary conditions.

20885.20: What is the potential limitation? Can it be briefly described? At present this statement is too vague to be informative.

20887.1: How realistic is it to assume the spatial distribution is fixed? How might this bias the results of this work?

20887.5: As mentioned above, some discussion of how large such impacts might be would be worth including.

20887.23: Can the authors be more rigorous here and provide statistical analysis such as correlation coefficients, bias and error?

20887.24: Can the authors summarize the species specific evaluation of Conolly 2011? Does the model do better at estimating concentrations of any particular component of SIA? What were the biases, quantitatively?

20888.1: This seems rather unsubstantiated. How did the authors rule out the role of SOA? Why was particle-bound water not included in the model PM_{2.5} calculations (it is easily done using hygroscopic growth curves – textbook undergraduate level calculation)?

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20888.2: What evidence do the authors provide that such missing mechanism don't affect the sensitivities calculated here? It's not entirely implausible. For example, if they have neglected uptake of HNO₃ on dust, then they are overestimating their response of nitrate to changes in NO_x emissions. . . Or if they considered the role of NO_x on SOA, which can be quite significant.

20888.8: Likewise, some overestimation would occur for the background site. This affect may somewhat cancel the low-biases discussed above.

20888.10 and 26: It seems like one additional model run with boundary conditions set to zero could easily be performed to quantify this aspect more completely.

20889.13: This results is "key" to what, exactly? Also, why does this occur, from a standpoint of atmospheric chemistry and aerosol partitioning? If the authors wish to draw attention to this finding, it should be better explained.

20889.22: why?

20890.1: This could have been determined without any sensitivity model experiments by calculating the gas ratio (= available NH₃ beyond that required for sulfate neutralization, divided by total inorganic nitrate + nitric acid, Ansari and Pandis, 1998) in the baseline model run. A map of that ratio over the UK would be useful for this work.

20892.17: To be fair though, it may also be worth mentioning that NH₃ reductions would as well have additional benefits given their impacts on N deposition and ecosystems.

MINOR COMMENTS:

20882.18: "but" – what is being contrasted here? Maybe a different word would be better.

20882.24: "observation" – conclusion? "observation" implies a measurement

20883.9: should clarify that 3.2 million is exposure to ambient PM_{2.5} (as opposed to indoor, which is even larger)

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20884.1: I don't see how the mass concentrations masks composition. This could be re-written to be better, something like "while standards focus on PM_{2.5} mass concentration, meeting these standards are complicated by the considerable chemical heterogeneity. . ."

20884.21: usually write old to new in citations years

20885.16: reactions,

20888.16: It would be interesting to also see the % reductions.

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