

Comment on acp-2021-65

Anonymous Referee #1

Referee comment on "Non-linear response of PM_{2.5} to changes in NO_x and NH₃ emissions in the Po basin (Italy): consequences for air quality plans" by Philippe Thunis et al.,
Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-65-RC1>, 2021

General comments

The paper "Non-linear response of PM_{2.5} to changes in NO_x and NH₃ emissions in the Po basin (Italy): consequences for air quality plans" by Thunis et al. deals with a key aspect of air quality modelling that is the support in developing air quality plans.

The paper provides an interesting discussion about the role of non-linear atmospheric processes and their possible consequences on the robustness of the information that can be derived to support policy makers.

The paper takes advantage of previous works that defined a methodological framework as well as a set of indicators that allow to identify and quantify the role of main non-linear process from both a spatial and temporal point of view.

Therefore, the paper fits the scope of ACP.

The paper is well written, with concise and clear statements, and it does not require any substantial review of syntax and language.

However, before publication, there are a few issues that should be addressed by the authors, that are detailed in the following:

- The discussion on the results shown in a few key figures of the paper requires some checks and additional details concerning both the presentation of the results, but also the related discussion (see Specific comments for additional details)
- The link between “domain-based” emission reductions and the analysis at specific receptors should be partially revised and integrated (see Specific comments for additional details)
- Authors presented their results using several and very illustrative type of plots (maps, scatter diagrams, isopleths), but it seems that, in some case, results presents some inconsistencies; moreover, authors could consider to maybe introduce some additional links between the different kind of figure to support the discussion (e.g. between isopleths and maps,...)
- Annex 2 may deserve a partial review

There are also a few minor mistakes in references to figures to be fixed and some minor improvements in figures and captions that could be introduced (see Specific comments for additional details).

Specific comments and Technical corrections

P5 R207 – Are two empty brackets to be removed?

P6 R221 – Being “G” a ratio, the linear legend is probably not the most appropriate because it does not allow a “symmetric” comparison of value lower greater and lower than 1 (e.g. G = 2.0 and G=0.5)

P7 R294 – Figure 7? If yes, the content of this figure should be better introduced, because it is then used for discussion

P9 R354-356 – Authors should comment why interaction term is negative, although this result is expected because it is well known that a reduction of only NOX implies a reduction of both NO₃⁻ and NH₄⁺ and the same happens when reducing only NH₃, therefore a simultaneous reduction of both precursors is lower than the sum of the two.

P9 R363 – May authors better explain how the “hyperbolic shapes indicate this negative non-linearity in the NH₃-NOx interaction”?

P9 R379 – Figure 7?

P9 R373-379 – Figure 9 may deserve additional discussions... a few suggestions:

- Top right panel states that is clearly higher than in several areas and, moreover, looking for example at Bergamo in Figure 7, it is not even clear if there is a change in sign (i.e. if they indicate a PM reduction or increase, due to NOx reduction). Does this imply that the extrapolation of scenario results for NOx, in terms of policy, is particularly critical in such emission reduction range?
- In other works, same authors state that below 50% reduction the impact approach (i.e. emission reduction approach) can be considered linear up to 50% reduction: does this result allow to confirm such assumption?
- Bottom right panel states that is slightly higher than in some areas: any explanation?
- Is the comment concerning bottom left panel correct? Should it indicate that the interaction term at 50% is lower (i.e. "more negative") than the corresponding term at 25%, isn't it?

P10 R390 – Again... bottom left panel in figure 10, in principle, should indicate that interaction term at 50% is lower than the corresponding term at 25%, not providing information on the sign of each (P50 and P25) interaction term. Then, knowing that P25 is lower than 0, we can conclude that also P50 is also negative

P10 R392-394 – Maybe it could be more readable putting this comment after having introduced figure 11

P10 R395 – Does figure 11 show the last four terms of term of equation 4?

If yes, it is not clear to me the range of plotted values. For example, in summer case, figure 10 (Top left) states that the last three terms in the above equation ranges between -1. and 0. and figure 8 states that the first term of the above equation is negative; so, why in figure 11 (top panel) do red values range between 0 and 15 ug/m³?

P10 – R426-430 – Isopleth diagrams represent a very interesting tool to assess the impact of different NOx and NH₃ emission reductions on PM_{2.5} concentration, but authors should always point out that all the results, even if they are analysed at a single cell, derive from uniform emission reduction over the whole domain; therefore the key aspect to be highlighted is that, when comparing sites providing different answers to the same "domain-based" policy, it is not trivial to define a single domain-based policy reducing PM in both sites either identifying different policies (for example for specific sub-regions) again reducing PM in both sites.

P11 – R457-458 – Figure 9 seems stating that the system is rather sensitive to emission reduction between 25 and 50%, at least for NOx, so do authors think that their statement

"they are quite insensitive to the emission reduction levels at least up to -50% " is totally correct?

P12 R493 – Clappier et al is 2020 or 2021?

P16 R636 – "March" instead of "April"?

P16 R654-656 – Is the relation between sensitivity and triangles to be reversed?

P16 R657-662 – Explanation in second bullet is not very clear. Please check and rephrase it

P17 R670 – Caption should indicate that SIA are expressed in percentage

P19 R691 – A blank is missing between "to" and "alpha"

P22 R710 – A legend for colours is missing in figure 8 (left). Does figure 8 (right) shows daily mean values of each grid cell?

P23 Figure10 – Which is the lowest value in the colour legend?