Author reply to the reviewers of "Air Control Toolbox (ACT_v1.0): a flexible surrogate model to explore mitigation scenarios in air quality forecasts." Submitted to Geos. Model Dev. By Augustin Colette, Laurence Rouïl, Frédérik Meleux, Vincent Lemaire, Blandine Raux

In this response, the reviewer comments are highlighted in bold, author responses in plain text, and modifications to the manuscript indented in track changes with page and line numbering referring to the track change version of the revised manuscript.

The authors have done a good job in responding to many comments, and have improved the paper. I have only two remaining issues which prevent me from recommending publication of the manuscript as-is. The first comment relating to the model formulation is substantial but hopefully only due to unclear notation:

1) Eq 1 on p10: I appreciate that the authors have made an effort to explain the methodology better. However, on reading this part again, I am still quite confused:

a) Where is the source pollutant? I guess alpha, beta, gamma, deltas and epsilons are actually source pollutant specific? This should be clarified. The 'pollutants of interest' mentioned in line 4 (and which the C in Eq 1 refer to) are only the ambient pollutants, resulting from emissions of several precursor species.

b) The concentration changes in one grid cell (i,j) are related here to the emission changes \delta^{sec}_{i,j} of sector sec in this same grid cell only. I assume this is only an error in the notation, otherwise I don't understand how this can sensibly work since ambient concentration changes in one grid cell are necessarily related to emission changes elsewhere: This formulation would completely ignore any transport of pollution, which is both unrealistic as well as in contradiction to the authors' own statements in the introduction (p4, l 9-10). In particular, with this formulation I would not see how any effect of agricultural emission (changes) can be found in Paris in the March episode, since there are certainly no agricultural NH3 emissions in the grid cell located in central Paris. I assume these are total sectoral emission changes, i.e. \delta^sec = \sum_{i',j'} \delta^sec_{i',j'}.

We are very grateful for the relevant remark pointing an inaccuracy of the notation in the manuscript. This has now been revised as highlighted below. To answer directly here the questions of the reviewer:

(a) alpha, beta, gamma are indeed ambient air pollutant specific and also varying in space. Delta are activity sector specific, but uniform in space and also applied identically to all emitted species of a given activity sector.

(b) it is right that spatial indices (I,j) should not have included for the emission reduction factor, which is applied uniformly over the whole domain.

The proposed modification is P10 L5 of the revised manuscript:

> For each day, and each pollutant, a polynomial model is calibrated at each grid point of the modelling domain. We introduce the following notations for a third order polynomial, with $\alpha_{i,j}, \beta_{i,j}, \gamma_{i,j}$ the coefficients (the later two being nullified for linear or quadratic forms):

$$C_{i,j} - C_{i,j}^{ref} = \alpha_{i,j} \cdot \left(\delta_{\cancel{i,j}}^{sec}\right) + \beta_{i,j} \cdot \left(\delta_{\cancel{i,j}}^{sec}\right)^2 + \gamma_{i,j} \cdot \left(\delta_{\cancel{i,j}}^{sec}\right)^3$$

Where:

$$\delta_{i,j}^{sec} = \left(\frac{\varepsilon^{sec}}{\varepsilon^{ref}} \varepsilon_{i,j}^{sec} - \varepsilon_{i,j}^{ref} \right)$$

- $C_{i,j}^{ref}$ is the air pollutant concentration (for either PM_{10}, $PM_{2.5}$, O_{3max}, O_{3avg}, or NO_2) modelled with the CTM for the reference simulation with emissions $\varepsilon_{i,j}^{ref}$
- $C_{i,j}$ is the air pollutant concentration modelled with the CTM for the sensitivity simulation with reduced emissions for sector "sec": $\varepsilon_{i,j}^{sec}$ reduced by a uniform factor δ^{sec} over the domain. In addition to being uniform in space, the reduction factor is also identical for all emitted precursor species since it is applied to the whole activity sector.
- throughout the paper, the coefficients α, β, and γ of such polynomials will be computed for each *i*,*j* pair of latitude, longitudes indices in the geographical modelling domain, so that the indices will be dropped in the following notations.

2) The lines in Fig. 3 are still not distinguishable. This could easily be fixed by iterating through colors and line styles independently, i.e. one color series with solid lines, one with dashed, one with dotted.

The color scheme was changed according to this suggestion for Figure 3 as well as Figures S.3, S.4 and S.5.