

## ***Interactive comment on “The success of emissions control legislation in mitigating air pollution is higher than previously estimated” by N. Daskalakis et al.***

**N. Daskalakis et al.**

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**We would like to thank the reviewer for the careful reading and the pertinent comments that helped improving this manuscript.**

Here-below we provide a point-by-point reply to the comments by the reviewer. Text that corresponds to new text in the manuscript is provided in *“quotes and italics”*.

**Comment:** A first remark concerns the main message of the paper that I tried to summarise above. Both the abstract and the conclusion sections remain rather vague about what has been exactly done, using rather loose words like "previously thought". I

think the main methodology should be clarified in the abstract and conclusion section.

**Answer:** Both the abstract and the conclusions sections of the manuscript have been rephrased in order to clearly state the methodology and scope of the manuscript.

In the abstract Page 1, line 7: *“...limiting the rapid increase of air pollutants than what is traditionally deduced through comparison of present-day atmospheric composition to that calculated using anthropogenic emissions representative of the pre-industrial period, due to...”*

In the conclusions, Page 11, line 6: *“...significant technology development than that calculated by comparing against constant anthropogenic emissions as is traditionally done.”*

**Comment:** A second remark concerns the results presented in figure 2. One could argue that the selection of stations seems rather arbitrary, and might be driven by the good performance at these stations. However, the appendix shows some extra material.

**Answer:** The selection of the stations shown in the manuscript and the supplementary material was made based on multi-year data availability and neglecting urban core stations that cannot be represented by our coarse model resolution. In addition, the number of stations shown is limited in order to keep the manuscript and supplementary material in reasonable lengths. However, the performance of the model has been evaluated based on comparison of all available measurements to the model results using the above-mentioned criteria and the derived overall statistics are provided in Table 1, as explained in the second paragraph of section 3.2.

**Comment:** What I find surprising is that the authors do not spend much time to highlight the clear imprint of emission reductions in the modeled atmospheric concentrations. Both the AE1980 and BA1980 scenarios are clearly not compatible with the observed atmospheric composition in later years. Although this sounds rather trivial I

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think this should be mentioned more clearly in the paper.

**Answer:** Indeed, the difference between the scenarios is clearly seen at some of the stations, especially those that are affected the most by anthropogenic sources. This indicates that the scenarios BA1980 and AE1980 that do not account for any legislation applied after 1980 fail to reproduce the observed levels of pollutants. As suggested by the reviewer this is now discussed in the manuscript at the end of section 3.2, although the effectiveness of applied legislation is analysed further in the document and depicted in Figure 4.

*“It is worth mentioning the clear imprint of the effect of emission legislation to the pollutant levels at the stations that are mostly influenced by anthropogenic activities and are depicted in Fig. 2 and supplementary Figures S5-S10. At these stations both the BA1980 and AE1980 simulations clearly fail to capture the pollutant levels observed the recent years.”*

**Comment:** I am also not a fan of the equations (with E-formatted numbers) in the plots. I suggest to summarise these in an extra table.

**Answer:** As for the equations that are printed in Fig.2, we wish to keep them as they are in order to make the direct link between each panel and the corresponding statistics. A separate table containing the equations would add unnecessary complication to the ease of reading and understanding the figure.

**Comment:** A third and final remark is about a worry I have with the resolution dependence presented in figure 4. CO and to a lesser extend NOX burdens are substantially larger in the 3x2 simulation. We talk here about differences up to 10%! The authors should at least analyse the cause of these differences. Lower global OH in the high resolution simulation seems a likely explanation (maybe driven by lower O3?).

**Answer:** This points to the spin-up time used for the 30 year simulations, which affects the way we have normalized the simulations to depict trends in Fig. 4. For this study we

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have applied one year spin-up time using the emissions and meteorology of the year 1980, i.e. by running twice the year 1980. Thus, all emission scenarios simulations started with the same conditions in 1980. In the fine resolution runs, the first years of the simulations have not reached the dynamic equilibrium needed for studying trends. Therefore, we have redrawn Fig. 4 by normalizing concentrations using those of the year 1982 instead of the year 1980 as was done before. This updated figure shows that the differences in the CO and NO<sub>x</sub> trends mentioned by the reviewer were due to this spin-up issue and the simulations CL and CL-fine produce very similar year-to-year changes.

Therefore, we have updated Fig. 4 in the revised manuscript by normalizing to 1982, i.e. considering the extra two years as a part of the spin-up time for the simulations. This is also clarified in the figure caption. The new Fig.4 does not require any change in the discussion of section 3.3.

Appropriate discussion has been added in the manuscript at the end of section 2.1, where we now provide information on the spin-up time of the simulations.

*“For this study, one year spin-up time using the emissions and meteorology of the year 1980, i.e. by running twice the year 1980, has been applied. The fine resolution simulation had not reached dynamic equilibrium after one year, as needed for studying the year-to-year changes. Therefore, the year 1982 has been used as reference year to normalize the concentrations in Fig.4 in order to study relative changes in section 3.4.”*

**Comment:** For other technical corrections, please see the attached pdf.

**Answer:** All suggestions of linguistic corrections marked by the reviewer in the pdf, have been addressed in the revised manuscript.

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