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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The success of emissions control legislation in mitigating air pollution is higher than previously estimated" *by* 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"*.

General comments

Comment: The underlying premise to this paper is a good one: when we estimate the

impact of emissions controls, it makes much more sense to compare to a projection of where we would be without them, rather than just assuming no emissions change as the baseline. It is important for policymakers to realise the true benefits that air pollution legislation has brought. Of course, the "true benefit" is always going to be a model construct, as we don't have two planets to monitor.

Answer: We thank the reviewer for the positive comment.

Comment: The choice of reference scenario is always going to be a bit contentious. What the authors have done here is probably reasonable (I am not an expert on constructing emissions scenarios) - however they describe the scenario they use as the reference as a "worst-case scenario" - which is patently wrong, as for some regions the emissions in the "current legislation" scenario exceed those in the worst-case (see specific comments below). The phrase "worst-case" should not be used.

Answer: Indeed the scenario described here is incorrectly named worst-case. It was used in two different parts of the manuscript.

The first (Page 4, line 4-6) now reads:

"The third 30-year simulation is performed with anthropogenic emissions for the period 1980-2010 that have been constructed, as further explained, in order to account for population increase but neither for the globalisation of the industrial activities, nor for the legislation applied after 1980."

The second (Page 6, lines 5-6) now reads:

"...As a result, a new anthropogenic emission inventory was constructed..."

Comment: The paper is well organised and reasonably clearly written – but the English should be improved – I make a few suggestions below, but this isn't really the job of a scientific reviewer. For example the first line of the Introduction(!): "The rapid Earth's population increase..." should be "The rapid increase in the Earth's population..."

Answer: Changes were made throughout the manuscript to improve the English, also following suggestions by reviewer 1.

Comment: If these things and the specific points below are rectified, then this paper should be acceptable for publication in ACP.

Specific comments

Comment: P1 L20 (and elsewhere) 80's → 80s (or possibly 1980s, or '80s, but definitely not 80's); also threat → threaten

Answer: We changed **80's** to **80s** throughout the manuscript.

Comment: P2 l13 Do you mean troposphere, rather than atmosphere? I believe the main thing driving the increase in tropospheric O3 burden between 1890 and 1990 is the increase in anthropogenic emissions. Lamarque et al (2005) find a decrease (not increase) in O3 lifetime of 30%.

Answer: We thank the reviewer for pointing out this typing error. The text now reads:

"This is linked to a decrease of O_3 *lifetime in the troposphere by about 30% (Lamarque et al.,2005)"*

Comment: P2 l28 Glacier?

Answer: Typo corrected.

Comment: P2 An obvious omitted reference here is Fiore et al (2012) (Global air quality and climate, Chem. Soc. Rev., 41, 6663, doi:10.1039/c2cs35095e).

Answer: The paper by Fiore et al (2012) focuses on future changes in global air quality and their impact on climate (period covered 2000-2030 and 2050). This is the main reason for not having a reference to that paper in the introduction. However to satisfy the reviewer, we now discuss the findings from the first 10 years of their simulations

and the following comment is added in the second paragraph of the introduction:

"Fiore et al (2012) analysing observations and simulations suggested that recent air quality changes and their uncertainty are mainly associated with emissions changes although climate warming degradates air quality."

Comment: The Introduction has rather more material on ozone than other air pollutants– one could argue that since the paper's title contains the words "air pollution" – and the most important air pollutants (at least for human health) are aerosols, this mismatch should perhaps be addressed.

Answer: The following sentences are added in Page 3, line 16:

"The modelling study by Pozzer et al. (2015) also shows globally decreasing AOD trends for the period 2001–2010. Regionally the largest decrease is calculated for easern USA and western Europe, where the eastern Chinese region shows the sharpest increasing trend. Similar results are found in the multi-satellite study by Yoon et al. (2014), where regionally western Europe and eastern USA appear to have the fastest decreasing trends in AOD, while central and east China the fastest increasing trends in AOD. In agreement with that study the analysis of the measurements of surface concentrations of several aerosol species by Leibensperger et al. (2012) shows decreasing trends in the eastern US for the period 1990–2010"

Comment: P3 l24 Do you mean multi-annual, rather than interannual?

Answer: We changed the term interannual to transient to all occurrences in the manuscript where we refer to the simulations (not the calculated results).

The manuscript now reads:

P3 L24 *"For the present study, a set of three different transient global three-dimensional chemistry transport simulations..."*

P5 L4 *"Three global chemistry–transport transient simulations of atmospheric compo-*

sition changes..."

Comment: P4 l5 targets the simulation → simulates

Answer: Changed in the manuscript.

Comment: P4 l18 Maybe there is ice-core data for 1979-89, but I think perhaps you mean firn air data?

Answer: Indeed it is not scaled to ice-core data, but to flask data. The sentence now reads: *"For the years between 1979 and 1989, the* CH_4 *surface distribution of the year 1984 is scaled to fit the observed* CH_4 *data of the respective year."*

Comment: P5 l11 Define all acronyms at first usage (HTAP).

Answer: Definition added in text.

Comment: P5 l14 Fix double negative: "...does not account neither..." (also elsewhere)

Answer: Changed to *"...does account neither..."* in all occurrences in the manuscript.

Comment: P5 l18 Clarify what is done with shipping (and aircraft) emissions in these simulations (you refer to land anthropogenic emissions).

Answer: The last sentence of section 2 explains that shipping and aircraft emissions are from the ACCMIP database. We now further clarify in section 2.1 that these two datasets are used in all simulations. The sentence page 5 line 11 is rephrased as follows:

"All anthropogenic emissions with the exception of shipping and aircraft emissions were different between the simulations. Aircraft and shipping emissions were the same for all simulations. "

Comment: P5 l25 worldbank

Answer: Typo corrected.

Comment: P6 l3 The Business As 1980 (BA1980) case is described as a "worst-case" scenario, but this is misleading. For example, in some regions, for some species, the Current Legislation (CL) scenario actually shows larger increases between 1980 and 2010!! So it isn't really the worst case, is it?

Answer: Indeed the BA1980 scenario is not the worst-case in all cases. 'worst-case' was removed and the text was rephrased appropriately (see reply to the general comments).

Comment: P6 l31 2 AND 3, ... respectively (I guess)

Answer: Corrected.

Comment: P6 l33 What are the "emission ratios" referred to? Clarify.

Answer: The emission ratios mentioned here are those presented in Table S2. They indicate how different are CL and BA1980 scenarios (Table S2a) as well as the CL and assumed (not simulated) "worst-case" scenario where the energy demand is taken into account along with the population increase. The sentence has been rephrased as follows:

"However, when comparing CL to BA1980 emissions for India and China by examining the ratio of the emissions in CL to those in BA1980 (Table S2), most ratios are lower than the corresponding increase in energy use per capita."

Comment: P7 l2 Again, I am not sure you mean "interannual".

Answer: Word "interannual" was removed from the sentence. It now reads:

"The CL to BA1980 comparison indicates that some improvements in air quality have been achieved in these countries during the recent years although they can not be seen in the trends of the CL emissions over these regions that show emission increases"

Comment: P7 l16 spatial

Answer: The typo was corrected.

Comment: P8 l9-18 The discussion of simulated vs observed trends does not match up with what I glean from Figures 2 and S5-S10. For example, you say "O3 and CO trends are also [nicely] well simulated, both in direction and in magnitude in most stations". For CO, the ratio of the simulated CL trend to the observed trend at the seven stations shown is 2.3, 0.9, 0.02, 0.91, 0.45, 0.94 and 0.88. For O3, the ratios are: 0.6, 0.01, 0.41, 0.22, -0.46, 2.8, and 0.84. I think the trend magnitudes for O3 cannot really be described as "well simulated".

Answer: The text now reads:

"CO trends are also well simulated, both in direction and in magnitude for most stations. O_3 *trends are generally underestimated by the model. "*

Comment: P9 l4 Do you mean Figure 4 rather than Figure 3?

Answer: We thank the reviewer for noticing. The figure reference and number were corrected in the manuscript.

Comment: P9 l13 I think the climate impact on concentrations may be arising through factors other than simply changes in natural emissions brought about by variations in climate.

Answer: The sentence is changed to clarify that meteorology and climate driven natural emissions induce significant variability in air quality in these regions. It now reads:

"In Fig. 4, it is clearly seen that the climate impact on surface concentrations of O_3*, OC and BC results in increases in their levels by... China, indicating that changes in meteorology and climate-driven emissions induce significant variability in air quality in these regions."*

Comment: P10 l17 are modifying → have modified

Answer: corrected.

Comment: P10 l21 may or may not → do or do not

Answer: corrected.

Comment: P17 Table 1: define R

Answer: R is now defined in the table caption.

Comment: P18 Figure 1: I can't distinguish the different symbols for different regions.

Answer: Figure 1 was replotted with larger symbols.

Comment: Table S2b: As commented on above, some ratios (CL/worst-case) are >1, which indicates that "worst-case" must be an oxymoron.

Answer: Changed to CL/energy-demand which is more descriptive of the case analyzed.

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