

## ***Interactive comment on “Impacts of global, regional, and sectoral black carbon emission reductions on surface air quality and human mortality” by S. C. Anenberg et al.***

**Anonymous Referee #1**

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General comments:

This is a most interesting paper that examines the health impact of halving anthropogenic black carbon emissions both globally and for different world regions as well as by sector. The authors calculate avoided cardiopulmonary and lung cancer deaths associated with chronic PM<sub>2.5</sub> exposure using PM<sub>2.5</sub> concentrations simulated by the MOZART-4 chemistry transport model. They present interesting findings in terms of mortality impacts per unit BC emissions, and SO<sub>4</sub> concentration increases that result from BC as well as BC+OC emission reductions. They highlight the co-benefit of BC-related emission reductions that will also tend to reduce OC. They find very little

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direct health benefits relating to BC emission reduction outside of the source region. The concentrations-response factor sensitivity analyses are most useful providing insights into uncertainty associated with health impact estimation. The paper is very well-written although it contains some very dense text and most of my comments relate to improved clarity for the reader.

Specific comments:

S1. The abstract discusses East Asia (EA) and South Asia (SA) but the rest of the text discuss EA and IN which is inconsistent. Discuss either IN and CH or EA and SA and modify the text and Tables and Figures accordingly.

S2. The abstract should mention the results of the sensitivity analyses in section 4. It would also be very worthwhile to outline the SO<sub>4</sub> changes here.

S3- Abstract line 20, section 3.2, page 10666, line 27. section 6, page 10670, line 28. “impacts of residential BC emissions are underestimated since indoor.. excluded”. Can you be sure that this statement applies globally or is more likely to apply in developing world regions? In your main body text could you provide a reference or state for which regions this underestimate is likely to be most pronounced? In the abstract you could consider adding “likely” before “underestimated”.

S4) section 2.1, page 10658 line 14, .and section 3. 2. page 10666 lines 10-14. It seems rather strange to discuss 8 major world regions and then “plus the US alone”. Table 1 doesn’t contain results from “US alone”. Similarly the text in section 3.2 and Fig S19 seems out of context given the focus on world regions in the paper. I’m not sure of the added value of this short paragraph of text in section 3.2 (especially as the 2nd sentence “Compared with . . .” is rather complicated and confusing) and the additional figure. If kept, this sentence should be explained more clearly and simply if possible and line 13 “causes avoided deaths in NA to increase” should be re-phrased.

S5) section 2.2 page 10659, lines 6-9. “Population.. generally larger. . . , indicating

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co-locations compared with OM and SO<sub>4</sub>". This conclusion is unclear. The populated-weighted average values in Table S2 are in all cases larger than the simple average. A clearer justification of co-location is needed. Quoting the range of values for a factor that gives the ratio of the population-average to the simple average for the different chemical species would be more convincing.

S6) section 2.2, having performed a detailed model evaluation, these results should be commented on, in terms of how they might influence the avoided mortality estimates in the "uncertainties" section (section 5) of the text.

S7) section 2.3, very briefly outline why you consider only chronic and not acute or short-term exposure.

S8) section 2.3, if the observed range of concentrations is up to 22.2 μg m<sup>-3</sup>, how can linearity be demonstrated to 30 μg m<sup>-3</sup>?

S9) section 3.1, the text concerning SO<sub>4</sub> changes shown in Fig 5a and S14 are most interesting. NO<sub>3</sub> concentrations seem also to be slightly affected by the BC concentrations, and again the sign of the change is different in the BC and BC+OC experiments. An explanatory sentence on the NO<sub>3</sub> changes would be useful.

S10) section 3.1, page 10664, line 19. It would be useful to add a further sentence describing the differences in magnitudes between the O<sub>3</sub> and OH changes in the Bc vs. BC+OC simulations.

S11) section 3.1, page 10664, lines 19-26, this text is confusing and rather detailed. Describe the results of this paper, and then examine how they compare with a previous study rather than the other way around.

S12) The scales on Figs 4 and 6 (also for Figs.S15-S18) are not the most informative; can these be revised?

S13) Figs S4-S8 concerning PM<sub>2.5</sub> = BC+OM+SO<sub>4</sub>+NO<sub>3</sub>; Fig S4 shows maximum PM<sub>2.5</sub> concentrations of ~50 μg m<sup>-3</sup> over EA. But the addition of maximum values for  
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the individual PM 2.5 components as given by the scales in Figs S5-S8 fall somewhat short of this (~10 μg m<sup>-3</sup>). If there is no missing PM 2.5 component (?), then the scales in either Fig S4 or Figs S5-S8 are misleading. Can these be revised?

S14) Figs S9-S10, the text in section 2.2 discusses the results of these figures in terms of underestimates and overestimates model results. However the plots have a large number of green-coloured points. It is impossible to know if these points represent underestimates or overestimates due to the choice of scale which spans negative to positive values). Revise this colour scale for clarity and text in Section 2.2 if necessary.

S15) Fig S17 doesn't look much different from Fig S15, is it necessary?

Technical corrections:

T1) Abstract, line 6 insert "individually" or some other phrase before "from eight world regions" for clarity.

T2) Abstract, line 16: "Globally ...1.3, 1.2". This sentence is difficult to follow. The fuller explanation given in section 3.3 would be useful here.

T3) section 2.1 page 10658, line 18 "Because each source" – add at least "emissions" and be more specific if possible.

T4) Section 2.2 page 10659, lines 18-20. Give the years and number of sites for IMPROVE and EMEP to be consistent with the information provided for the China and Indian sites. The text "surface observations ..outside ...Europe are limited". However, the number of EMEP sites used (for BC at least in Fig 3) is about the same or less as for India or China. Re-phrase the text to reflect this.

T5) Section 2.2 page 10659, line 23. "Each of these. . .", clarify if "these" includes also IMPROVE and EMEP measurements or not.

T6) Section 2.2 page 10660 lines 5-16. Add "USA" after "after "Northeast" etc and "Europe" after "in the West", to avoid confusion with World regions.

T7) section 2.2 page 10660, lines 15-25, clarify text concerning “lower and “higher” simulated values as compared to observations. Are simulated BC concentrations for EMEP locations not always lower in Fig 3? Add generally” before higher” when referring to SO4 for EMEP locations in Fig. S10. In Fig S11 simulated values are not always lower for regional and urban locations. Relate the sentence “Measurement methods . . . potentially higher EC than . . .EMEP” to the results in Fig 3.

T8) section 3.1, page 10663, line 7, add “by” before “25-49”.

T9) Section 3.1 page 10663, line 11. Fig 6 is not described where it is referenced and is not that informative with its current scale. (see comment S12).

T10). Check % or ratio results in sections 3.2, 3.3 and 6 as compared to the values entered in Table 1, Table 3 or given earlier in the text.

Page 10665 line 7- 33%

Page 10667 line 4- 1.3

Page 10667 line 9- 15%, 19%, 59%

Page 10670, line 21- 54%

T11) section 3.2, page 10665, lines 25-26, add a reference to Table 1 here; values in Table 1 are slightly different from the values given in the text.

T12) section 3.2 page 10666, line 2), refer to Table S3 here.

T13) section 3.2, page 10666, lines 7-9 “This is likely . . .smaller –per- unit. . .”, this sentence is confusing; is Table 2 the right Table to refer to?

T14) section 3.3, page 10666, line 19. Fig 1 does not have a global category- this would be useful.

T15) section 3.3 page 10667, line12, this text is a repeat of text at the beginning of that paragraph.

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T16) section 3.3 page 10667, line16, “the same pattern”- be more specific do you mean the same ranking? Re-phrase “The only exception. . .”

T17) section 4, page 10667, line 26, is “much higher” more appropriate?

T18) section 4, page 10668, line 4, “marginal” is confusing.

T19) section 4, page 10668, line 11, add “as compared to the standard 50% global BC reduction experiment” for clarity.

T20) section 4, page 10668, line 16, it is difficult to see any reduction for SE/AU- is it worth mentioning?

T21) section 5, page 10669, line 10, re-phrase “and a component of OM”.

T22) Fig 2- it is difficult to see any BC contribution (3-5% is stated in section 2.2) in most regions in Fig 2. Is it possible to enlarge the figure or expand the low values for clarity?

T23) In the caption for Fig 3, re-iterate what the dashed lines represent.

T24) In the captions for Figs. 5 and S15, add that negative values represent increases for clarity.

T25) In the caption for Table S2, it would be helpful to remind the reader than the total PM2.5 values are given in Table 1.

T26) What do the black colours in Fig S15. represent?

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Interactive comment on Atmos. Chem. Phys. Discuss., 11, 10653, 2011.

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