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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The impact of residential combustion emissions on atmospheric aerosol, human health and climate" *by* E. W. Butt et al.

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This paper examines the ambient health and climate implications of aerosols from residential fuel combustion. The explore uncertainties through sensitivity simulations. The paper is well-written, informative and well-suited for ACP. I have several minor recommendations that I would like to see addressed before publication.

Introduction

- The difference between 'residential emissions' and 'residential solid fuels' is not made until later in the paper. Might be useful to describe in paragraph 2.

- P20454: In review of previous work, please add Kodros et al. (2015) to this re-

view (I would have liked us to include your paper too. . . I did not realize that you were going to submit around the same time we were submitting our revisions, sorry). Similarly it would be good to include comparisons to this paper when looking at number changes and climate changes. Emissions inventories are not exactly the same (biofuel vs. residential), but largely overlapping. It seems like globally the results are similar but regionally there can be some big differences.

- P20455: In the health effects discussion, please discuss that with a coarse CTM that one only captures regional ($\sim$200 km mean values) air-quality effects on health, not indoor or even intra-village concentrations. If the models were run at higher resolution, health effects would likely be stronger (and this still does not even include indoor exposure).

Methods

- What is meant by 'commercial sector'? Are solid fuels also used in the commercial sector?

Section 2.3: In-situ measurements

- What is the basis for the highlighted regions in Figure 2. Africa, Russian Federation and Southeast Asia in particular have huge and diverse regions without measurements. How do measurements in the country of South Africa represent the Congo or the Sahara regions?

- What is assumed about C14 for RSF (how to distinguish coal vs. modern carbon?)?

Section 2.4: Health

- Briefly mention why using population over 30.

Section 2.5: Rad effects

- Volume weighting (homogeneous internal mixture) will lead to a more positive effect (and is unrealistic since it would require the BC to spread itself through the scattering

material). This should be stated and discussed as a limitation, and please mention the wide range of DRE uncertainty from biofuel due to optical mixing assumptions as shown in Kodros et al. (2015).

- Equation 4 – units don't work out. Did you mean to the 1/3 power not $\frac{1}{2}$? Typo?

Section 2.6: Model Simulations

- The use of 'emission ratio' does not seem to be the best descriptor here. The total mass of emissions are also changing in the 'emission ratio' simulations (as opposed to holding the mass of emissions fixed while changing the ratio).

- Please put the assumptions about the emitted size distribution in the small and large simulations in the main text. It took me a bit to realize they were in the footnotes of Table 3 (it said this when Table 3 was introduced but not when it was talked about in depth in Section 2.6).

3.1 Model Evaluation

- Figure 3: What does each datapoint correspond to? Are these each sites at multiple times or just averaged over all times available? Were the times of the model co-sampled with the times of the measurements or a comparison with the overall averaged values of the model with the overall average values from the measurements (that may have been for different times)? Are you averaging over the entire regions defined in Figure 2 or using the grid box of the site? Also would be good to include the number of datapoints.

- Figures 4-6: I can't read the yellow writing in the legend. The 'res_off' simulations are not included. It would be beneficial to see how including res emissions changes comparisons

- Figures 4-6 are used to suggest smaller res emissions are unrealistic. It would be good to explicitly acknowledge that other errors in the model limit the ability determine this for sure.

- Figures 4-6: It would be helpful to explain why the number of simulations differs between plots (I assume because some simulations have little effect on the masses, only number).

Section 3.2: PM Changes

- When discussing which species contribute the largest change to PM2.5, absolute changes in BC, POM, and SO4 mass are given. Is this the mass for the species with Dp less than 2.5 microns? This should probably be stated.

- Uncertainties in the assumed modern/fossil carbon ratio of residential burning. How much does this impact the comparison?

Section 3.3: Health Changes

- Should discuss that running at higher resolution would likely lead to a higher number of deaths since emissions likely correlate with population density (so coarser grids smear this effect).

- It is stated that the health results are most sensitive to changes in emitted POM mass. But is this just because the POM is the largest emitted species, so doubling this causes the greatest change PM change? The C-R response function is not determined by species. Or on the other hand, does this have something to do with spatial OC:BC ratio (perhaps caused by fuel type correlated with population)? This is not discussed.

- Figure 9 should really say res_base - res_off, right? Similar comment for Figure 10 (the "off" simulations are required as a health baseline).

- "To our knowledge, this is the first study of the global excess mortality due to ambient PM2.5 from residential cooking and heating emissions. A recent study by Chafe et al. (2014) concluded that ambient PM2.5 from RSF cooking emissions resulted in 420 000 annual excess deaths in 2005 and 370 000 annual excess deaths in 2010." Please stress that Chafe removed heating, or maybe add "both" to the first sentence. It took me reading these sentences a couple times to realize how they were not contradictory.

Section 3.4: Number

- Can you include brief comparisons to Kodros et al. (2015) to this and the following sections when comparisons are relevant? - Why say 'CCN' instead of N50? It's probably more precise to just call it N50 and say in the text that this is a proxy for CCN. Again changes to N50 most sensitive to changes in POM. That is just a mass thing though right? This has nothing inherently to do with OM vs BC other than the emissions mass of OM is higher, right? - Figure 12 colorscheme. . . Blues for both positive and negative numbers. . . this is very misleading. Please make all blues negative and red positive (even if it means the plot has very little of one color). This will allow the reader to instantly recognize which regions have increases vs. decreases.

Section 3.5

- Figure 13: Same comment as Figure 12.

Discussion and Conclusions

- Should reiterate that running at higher resolution would likely lead to a higher number of deaths since emissions likely correlate with population density (so coarser grids smear this effect).

- "Furthermore, BC particles coated in a non-absorbing shell produce stronger absorption than the BC core alone (Jacobson, 2001), which we do not treat here." Note, that coating BC yields more absorption than assuming BC and scattering species are *externally mixed*. However, you treat all species as being volume internally mixed (the BC is homogeneously mixed throughout the particle), which give *more* absorption than core-shell. This is discussed in the Jacobson, 2001 article.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 20449, 2015.