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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Particulate emissions from residential wood combustion in Europe – revised estimates and an evaluation" *by* H. A. C. Denier van der Gon et al.

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Answer to referee comments from Referee#1 regarding: Particulate emissions from residential wood combustion in Europe – Revised estimates and an evaluation Hugo Denier van der Gon (1)*, Robert Bergström (2,3), Christos Fountoukis (4), Christer Johansson (5), Spyros N. Pandis (4,6), David Simpson (7,8), and Antoon Visschedijk (1)

We are glad that the referee found the paper interesting, well-written and recommends it for publication. We thank the referee for useful comments for improving the

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manuscript.

Specific Comments: 1) I would like to see some discussion of how well the CTM models simulate the boundary layer during cold calm night time conditions when residential wood combustion emissions tend to be maximum. Do the CTM's overestimate or underestimate the PM concentrations in these cases?

Answer: This is a good point. It is difficult to model the boundary layer height accurately in large scale CTMs and there is a risk that the models will underestimate PM from residential wood combustion (and other local, low stack-height sources) during calm, cold nights with strong temperature inversions. If the model overestimates the mixing height during these conditions (which is very likely) the PM concentrations due to local residential wood combustion will be underestimated close to the source. However, the turbulence parameterization and calculation of the atmospheric boundary layer (ABL) height in the EMEP MSC-W model were updated a few years ago (Jeričević et al., 2010) and evaluation against radiosound data, and data from the Cabauw tower, showed that the EMEP model is able to reproduce spatial and temporal mixing height variability fairly well. Since measurements of the ABL are usually not available for the same sites (and time periods) as the PM concentrations we cannot directly compare the model bias for PM in the present study to observed ABL. Instead we have compared the model bias for OC to the modelled mixing height (Hmix) and air temperature at 2m height (T2m). This may give some indication if there are general problems with under or overestimation in the model during cold and stable conditions.

The correlation between the model bias (for OC) and Hmix or T2m varies between the six different sites included in the 2007-2009 evaluation of the EMEP MSC-W model. When looking at all (winter-half year) data from all six sites (Fig. A1), there is a tendency that the model underestimates OC for periods with low model Hmix, when using the old emission inventory for RWC (but the correlation between OC-bias and Hmix is fairly low, R2=0.084). When using the updated RWC emission inventory (TNO-newRWC) the underestimation at low modelled Hmix decrease markedly and the cor-

ACPD
14, C13030–C13039, 2015

relation between the OC-bias and Hmix drops to a very low value (R2=0.017, see Fig. A2).

Figure A1. Scatter plot of model bias for particulate organic carbon (OC) concentrations with the old (EUCAARI) emission inventory for residential combustion [model OC - measured OC] and modelled boundary layer height (Hmix) using winter half-year (Nov-Apr) data from 2007-2009 from the six stations Hyytiälä, Aspvreten, Vavihill, Melpitz, Overtoom and Birkenes (see manuscript for further details).

Figure A2. As Fig. A1 but model OC bias based on simulation with the new (TNO-new RWC) emission inventory.

The correlation between the model bias for OC and near surface temperatures is close to zero, both with the old and with the revised RWC emission inventory (see Fig. A3 and A4). So our final answer to referee 1 on this point is that at least for total OC, the EMEP MSC-W model does not seem to produce significantly worse results at low temperature periods than during milder conditions. Since OC is by far the dominant component in PM from RWC, this conclusion holds for PM2.5 or PM10 as well.

Figure A3. As Fig. A1 but plotting model OC bias against modelled 2m-temperature (T2m).

Figure A4. As Fig. A3 but model OC bias based on simulation with the new (TNO-new RWC) emission inventory.

Reference: Jeričević, A., Kraljević, L., Grisogono, B., Fagerli, H., and Večenaj, Ž.: Parameterization of vertical diffusion and the atmospheric boundary layer height determination in the EMEP model, Atmos. Chem. Phys., 10, 341–364, doi:10.5194/acp-10-341-2010, 2010.

We will add the above discussion to the Supplement of the paper and add the following text to the manuscript (in Section 4.2):

It is difficult to model the boundary layer height accurately in large scale CTMs and

ACPD

14, C13030–C13039, 2015

there is a risk that the models will underestimate PM from residential wood combustion (and other local, low stack-height sources) during calm, cold nights with strong temperature inversions. However, using the EMEP MSC-W model we find essentially no correlation between either mixing height or temperature and model bias for OC (see Supplementary information).

2) The abstract is a bit vague when referencing the different emission inventories (i.e. use of the word "new" somewhat overused in a "new inventory". Perhaps a better label might be employed and referenced in the abstract.

Answer: Probably a better phrasing would be "revised" since we do not start from scratch and all other sources were kept constant. In the abstract and the discussion text we will replace "new" with "revised" and will introduce "TNO_new_RWC" as the abbreviation of the TNO emission inventory with revised emission estimates for residential wood combustion. We prefer to keep this abbreviation as it is more compact, remaking all figures is additional work but mostly to avoid confusion since some other researchers / papers already refer to the new-RWC using the ACPD reference. Completely removing this abbreviation might suggest this is yet again another inventory (e.g. a "revision" of the "new" inventory). We hope this is a satisfactory solution to the referee.

Technical Comments: 1) Wood use factor units are sometimes referred to as GJ inhabitant-1 or GJ person -1 In the article and supplement. Use consistent units throughout.

Answer: We will change to consistent units (GJ person-1) in both the MS and the supplementary material. (see fig 5 here (in paper Fig 2) with revised axis title)

2) The last sentence in the conclusions section "For a global assessment we would have to more carefully study the origin of emissions factors used, but global OA emissions from biofuel use could also increase significantly if condensable PM is fully taken into account." Does not add much to the article, is a bit confusing and seems like it

ACPD
14, C13030–C13039, 2015

doesn't belong to the rest of the paper. Perhaps it might be removed.

Answer: We will remove this sentence from the conclusions. We also slightly modified the final sentence in the abstract: Old: "Since usage of biofuels, such as wood, in small combustion units is a globally significant source, this insight may also dramatically change global estimates of organic aerosol emissions." New: "Since usage of biofuels in small combustion units is a globally significant source, the findings presented here are also relevant for regions outside of Europe."

Please also note the supplement to this comment:
http://www.atmos-chem-phys-discuss.net/14/C13030/2015/acpd-14-C13030-2015-supplement.pdf

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Interactive comment on Atmos. Chem. Phys. Discuss., 14, 31719, 2014.

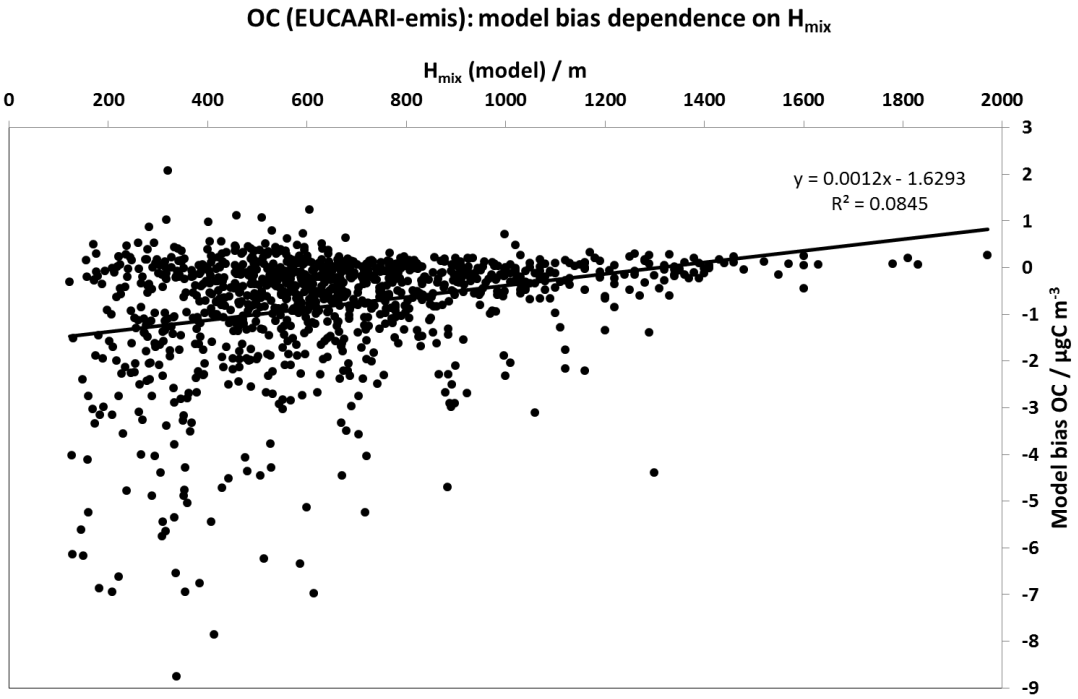

Fig. 1.

ACPD
14, C13030–C13039, 2015

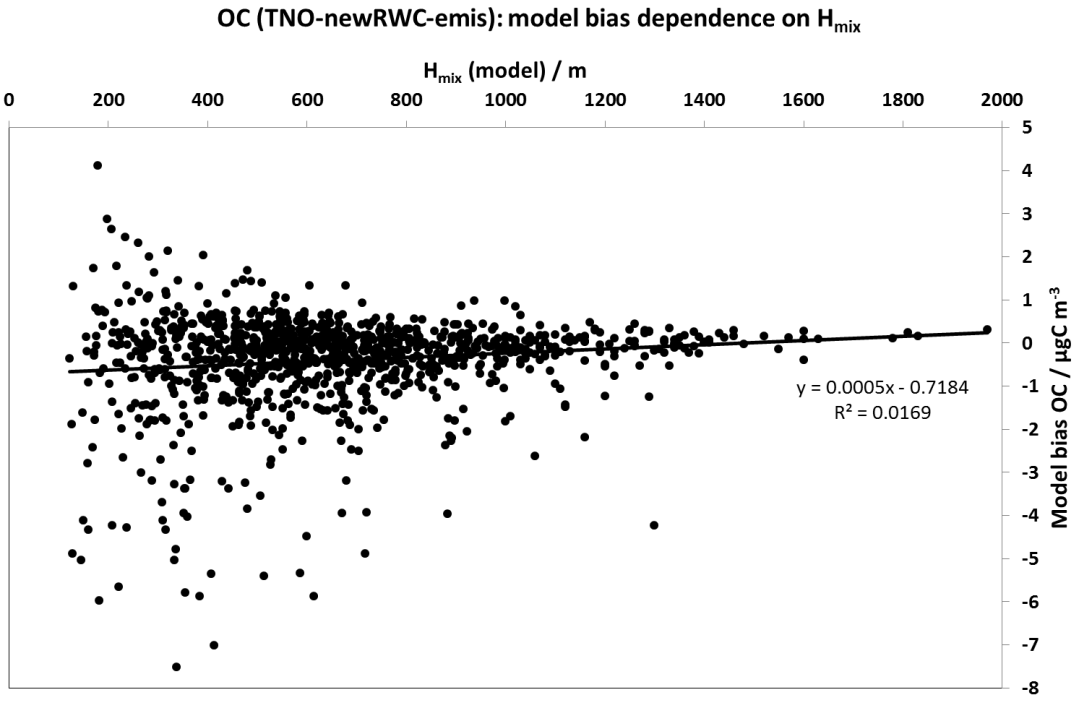

Fig. 2.

ACPD
14, C13030–C13039, 2015

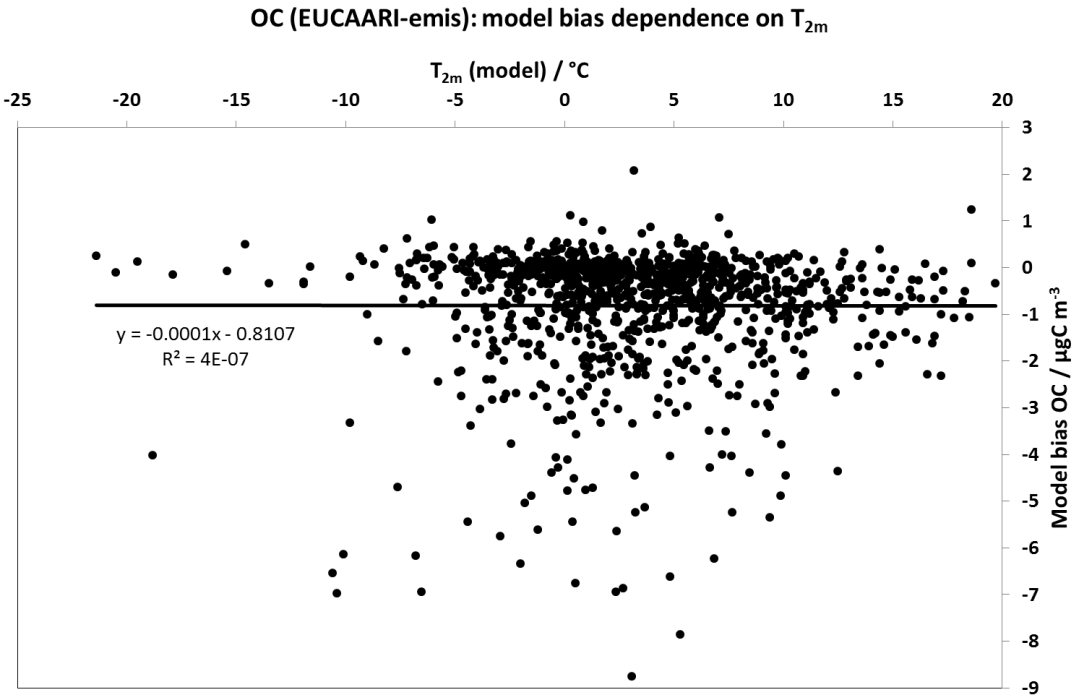

Fig. 3.

ACPD
14, C13030–C13039, 2015

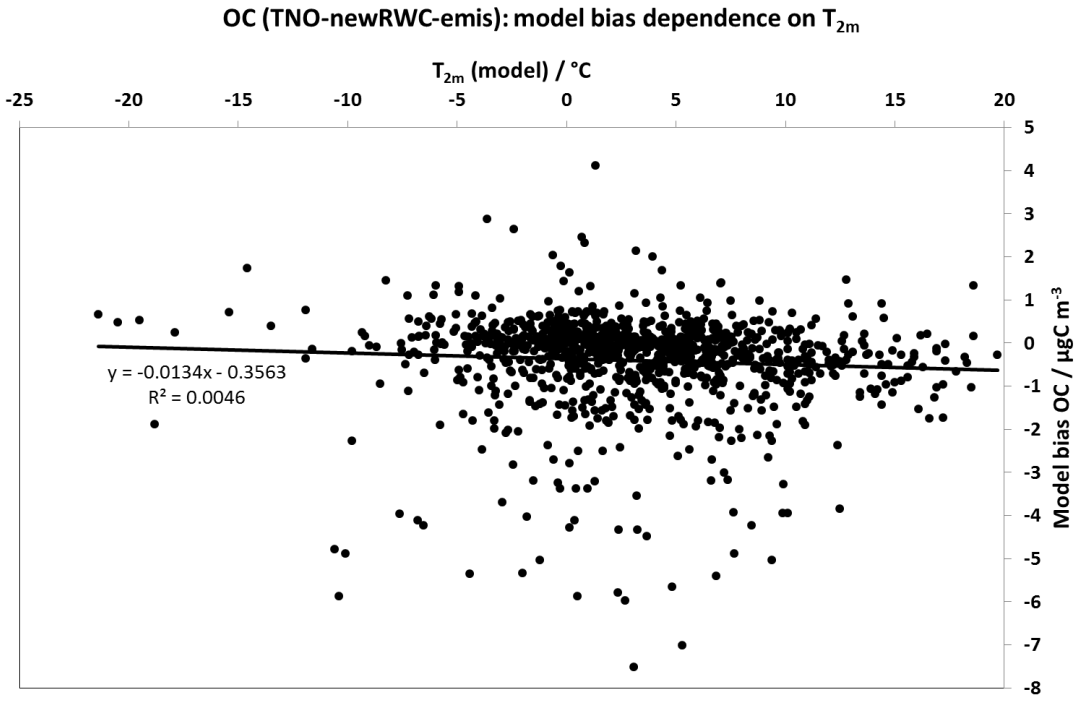

Fig. 4.

ACPD
14, C13030–C13039, 2015

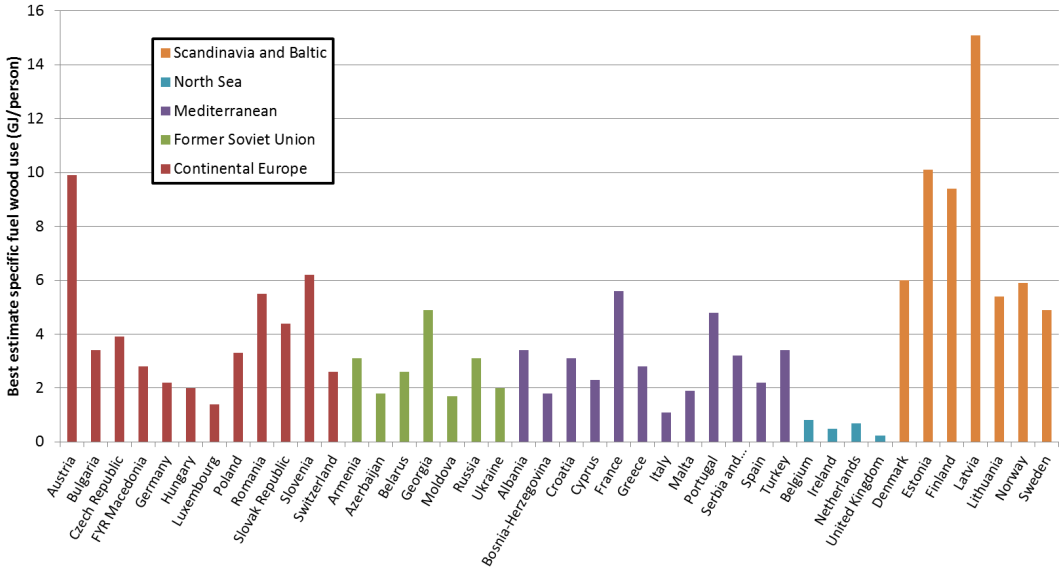

Fig. 5.

ACPD
14, C13030–C13039, 2015