Atmospheric
Chemistry
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Discussions

EGU

Interactive comment on "The MetVed model: Development and evaluation of emissions from residential wood combustion at high spatio-temporal resolution in Norway" *by* Henrik Grythe et al.

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General comments

In this response, rewiever comments are in blue, while the author response is in black. Where applicable, text from the paper that have been changed are in red. A document with tracked changes to the original manuscript has been added. We thank reviewers for insightful comments and suggested changes.

The manuscript addresses an important issue regarding air quality, as RWC is a major emission source in many countries with large influence on air quality, exposure and human health. The MetVed model uses a novel approach, including different detailed data sources. It is of high importance that the methodology is applicable in a similar or adapted version for other countries, though depending on the data availability.Verification shows that the model have limitations estimating real life emissions especially in wither, but still the model provide improvements according to other models. The high temporal and spatial resolution supported by the MetVed model allow for detailed air quality modelling, exposure assessment and human health effect estimation.

The manuscript provide a novel approach, that can support and improve the temporal and spatial RWC emissions inventories not only in Norway, and is found to be a valuable input to emissions and air quality studies.

Specific comments

The uncertainty of wood consumption is stated to be below 3 % with reference to SSB, 2018 (p5 l3). Does the authors find this uncertainty level accurate? How is untraded fuelwood handled and how widespread is the private untraded wood for RWC?

The total uncertainty on Norwegian consumption is larger than the 3% given in the text, this is the sample size uncertainty regarding representativeness of the interviewees. In Norway the consumption estimates are not based on sales, but on telephone interviews. The sample size uncertainty is 3% for Norway as a whole, which does not include uncertainty in peoples memory, uncertainty regarding quantification by different people etc. As the measurement is on consumption and not sales related, thus untraded fuels do not represent additional fuel or uncertainty in this regard.

Technical corrections

P2 L8 states that NOx and PM concentrations remain a major concern for human health, but health effects due to air pollution is not restricted to NOx and PM. This should be clarified.

added preposition "among" to sentence, it now reads: Together with nitrogen oxides (NO_x), elevated particulate matter (PM) concentrations remain among the major concerns for human health.

P2 L11-12: add reference

Reference to Genberg et al.,(2011) has been added.

P2 L13-14: add reference

Reference to Karagulian et al.,(2015) has been added.

C3

P3 L1: "In Norway, where there are approximately 3 million individual wood burning installations, and so establishing the emissions from each individual point source constitutes a challenge" should be corrected to "In Norway, where there are approximately 3 million individual wood burning installations, establishing the emissions from each individual point source constitutes a challenge"

Text changed as suggested by reviewer.

P3 L7-8: change "(CLRTAP; (http://ceip.at/))" to "(CLRTAP; http://ceip.at/)"

Text changed as suggested by reviewer.

P3 L23: could this statement be supported by more references than Timmermans et al., 2013?

P4 L4: change to "...heating demand, which..."

Text changed as suggested by reviewer.

P4 L14: change to "...in Norway, and energy..."

Text changed as suggested by reviewer.

P9 L15-18: you introduce 3 categories (inactive, secondary and primary) of RWC installations, but you only use the latter two categories in the MetVed model as "At the moment, there is no way to establish exactly which of the listed installations are in disuse". Could you extend this part with a description of what is needed to identify

C4

Added section: To detail out further the activity level of fireplaces, further data could be collected. In some municipalities, records of the residue material from chimneys swept are kept record of and graded on a scale from 1-9 (clean to dirty). These and similar data could be used directly to estimate the activity in each chimney, but would need a proper framework. Also consumption questionnaire presently asks respondents first if they have a wood firing installation then if it is in use, so this also supports finding the average share of inactive fireplaces.

P9 L33: it would increase the clarity if the equation is extracted from the text to a separate line with equation numbering. Further, check if the equation is correct or it should be PEHT=FPHT/NHT

The equation is extracted to its own line. The equation is correct as it stands.

P11 L10: missing a closing bracket

inserted.

P11 L25-26: It is not clear from fig. 3d that the CH4 EF show a general decline, as stated in the text. From the figure it looks as the CH4 EF is (almost) constant.

Both figure 3 and 4 together with the text describing them has been redone to be clearer.

As the reviewer points out, the methane emission factor is constant over time as the emission factor for "New" and "Old" ovens are the same. inserted except CH_4

P11 L 30-34: The difference between installations newer than 1998 is large be-

tween the fire rescue agency and the survey. Has the reason for the difference been evaluated? If the fire rescue data has large uncertainty, it is interesting to know if it is only the case for this parameter and why. If the survey have large uncertainty, e.g. due to limited number of respondents, it should be mentioned if the same survey is used for other information in the MetVed model.

In section 2.4 we write in detail on this. It is an interesting difference for a number of reasons. Though it is hard to conclude there are good reasons to believe the fire department underestimate the fraction of new ovens. In addition there are good reasons to assume that the average consumption is higher in newer ovens. The implications of this is that the role of the differentiating done from fire departments are used as statistical input (see sec. 3.4).

P12 L4: please clarify the method for estimating sales. What is the reason for choosing this methodology and what is the data foundation?

It is clarified ion the text that these sales numbers are based on the survey in the previous sentence.

P12 L11: clarify if CLRTAP refer to the Norwegian emissions reported to CLRTAP, as the phrasing can be misinterpreted to refer to the reporting guidelines for CLRTAP, which include EFs for more technologies than new and old.

Sentence now reads: Both Norwegian emissions reported to CLRTAP and MetVed assumes constant EF for the "New" oven assembly.

P12 L20: add reference to figure 4.c

added figure reference.

P13 L21-23: consider rephrasing this to make it more easy to read.

It now reads Due to large differences in the input data, the housing type and size and energy dependencies calculated within MetVed is done only based on the ENOVA reported total energy consumption.

P13 L23: change "...MetVed done based..." to "...MetVed is done based..."

Text changed as suggested by reviewer.

P13 L 29: what does NBV refer to? Include a reference.

"Norsk Beregningsverktøy" added to text

P14 L13: change to "...Norwegian official emission factors (Tab. 1) is used."

Text changed as suggested by reviewer.

P14 L16: change to "...exception. In..."

Text changed as suggested by reviewer.

P14 L21: change to "...EMEP) closely related..."

Not sure what the change would be.

P 14 L26: change to "...same scale, as..."

Text changed as suggested by reviewer.

P 15 L6: change to "...Trondheim, that has the fourth highest..."

Text changed as suggested by reviewer.

P15 L 17: change to "...Additionally, MetVed considers the dwelling size..."

Text changed as suggested by reviewer.

P 15 L 31: change to "...particle, subject only to..."

Text changed as suggested by reviewer.

P16 L 22: change to "...Compared to NBV emissions, which were calibrated..."

Text changed as suggested by reviewer.

P17 L18-19: change to "When apartment emissions were emitted in the second layer,the surface concentration was reduced to 3.76 μg^{-3}, and when smaller buildings emit in the second layer, a further reduction to 3.19 μg^{-3} is observed"

Text changed as suggested by reviewer.

P 18 L 6: change to "...dependence, suggesting that..."

Text changed as suggested by reviewer.

P18 L12: change to "...For most of the air quality stations..."

Text changed as suggested by reviewer.

P18 L16-17: change to "...All urban measurement sites..."

Text changed as suggested by reviewer.

P18 L34: change to "...the region, and the area..."

Text changed as suggested by reviewer.

P19 L3: change to "...other than wood based, which represent..."

Text changed as suggested by reviewer.

P22-24: the layout of references needs to be standardised

Journal article references have been standardised.

P22 L2: include year ("Aasestad, K., 2010:")

Journal article references have been standardised.

P22 L9: correct name format

Journal article references have been standardised.

P22 L13: include year("Denby, B. R., et al., 2013:")

Journal article references have been standardised.

P23 L34: correct year to 2000

GAINS reference corrected.

P24 L 8: include year

Seljeskog reference, year added.

P27: consider rearranging the maps 1-7 according to the location on the national map

This did not look good due to domain sizes and was not done.

P28:Figure 3a; consider changing the chart title to "National Norwegian firewood consumption and emissions" Figure 3c; clarify "EF producer" and "Producers EF" Figure 3d: change the layout. Not all categories/lines are visible, and it is not possible to distinguish PM2.5 and PAH, and CH4 and PM10

Both figure 3 and 4 together with the text describing them has been redone to be clearer.

P28: the figure text for figure 3c include errors and must be corrected. The layout of figure 3d should be improved, as different categories are visualized with very similar colors.

Both figure 3 and 4 together with the text describing them has been redone to be clearer.

P29: Figure 4a; what do the red and the green dashed lines show? Figure 4c; it is not clear what the yellow line shows. If it is the wood ovens efficiency, it indicates that the efficiency is decreasing. That doesn't sound correct, as the new stoves are more efficient.

Both figure 3 and 4 together with the text describing them has been redone to be clearer.

P13 L 11-12 seem to describe that the yellow line show the decreasing fuel consumption? Please clarify both in the text and in the figure text.

We have slightly rewritten the paragraph on page 13 to be more clear. Both figure 3 and 4 together with the text describing them has been redone to be clearer.

P29: Figure 4b; Y-axis % or % change (see L19-20)? Figure text; weighted by population or number of dwellings (see L18)?

Both figure 3 and 4 together with the text describing them has been redone to be clearer.

4c, You are absolutely right, this is not % change, but % of 2005 demand. In 4b the residuals are normalised and thus unit less as shown.

P31: The layout of figure 6a should be improved, as different categories are visualized with very similar colors. E.g. consider to decrease the number of categories (e.g. by leaving out offroad and shipping). Consider to change the order of the categories in the legend to follow the order on the chart.Figure 6 lack indication of a and b.

We decided not to remove emission sectors from this figure. While not all do-

mains have i.e. industrial emissions and not all stations are influenced significantly by emissions in each domain, the sectors overlap those used in other Norwegian AQ modelling and to connect it to other work done on these stations we feel that the loss of some layout is compensated by gains in the information the figure gives.