

*AC = Author comment*

## **GENERAL COMMENTS**

1) The modeling approach is consistent with previously developed population- based human exposure models for the U.S. and other European countries, but also takes advantage of available data for the region to advance certain aspects of the approach including development of individual activity sequences that are defined geographically in space and time, and modeled seasonal distributions of indoor/outdoor ratios by building type and age. These features of the model support the originality of the work and make it of broader interest for publication. **The manuscript should more directly note these unique aspects of the model and differences from previous approaches.**

*AC : We add a couple of sentences in the end of the introduction to highlight these original features and explain how the approach here is different from what is typically done in personal exposure assessment (lines 80-85).*

## **SPECIFIC COMMENTS**

### **1. Introduction**

1.1 Line 20-25: epi studies cited are 10+ years old and for the U.S. only, cite current epi studies and at least some for Europe/France for relevancy.

*AC : References on the health impact of atmospheric pollution have been updated in the introduction and eps studies for Europe and France in particular have been added (lines ~ 20-25)*

1.2 Line 55-60: other references may be more appropriate e.g. review paper by Dias and Tchepel (2018) doi:10.3390/ijerph15030558

*AC : We add the suggested reference to the review paper as well as references in there (line 64).*

1.3 Line 71 or 85: some motivation needs to be stated in this last paragraph of intro as to why the model was developed, what was the aim (e.g. for health impact assessment, epi study, etc.)? or just that now have essential components to combine in modeling approach?

*AC : We now explain the motivation behind the development of the personal exposure model (line 83-85).*

1.4 Line 76-77: include important detail that SIREN model used to develop seasonal distributions of indoor/outdoor ratios for each type of building. This is a unique feature that could be highlighted as it is not reliant on measurements for a few locations that may not represent the area's buildings and people spend the majority of time in these microenvironments.

*AC : The information is now added in line 91.*

### **2. Personal exposure calculation**

2.1 Line 90-93: repeated from intro so delete here or make 1 sentence for versus modeling.

*AC : We deleted these lines (lines 100-104).*

2.2 Explanation of exposure calculations with 3 equations seems excessive; don't need first equation (general text is fine) and equation 3 is also in Fig. 1 so consider edits to reduce repetitive text.

*AC : We now include only the equation that is actually used for the exposure calculation. Some small edits are also done in the text to integrate the modifications and deliver a more direct message.*

2.3 Fig 1: could be improved . . . make more clear the two calculations of inputs (concentrations, population activity sequences) with different color boxes within first and second horizontal boxes (also include 'microenvironment' with concentrations); add 'modeled' to 'PM2.5, O3' in first bullet under Outdoor concentrations, and 'buildings (modeled)' for first bullet under In- door/Outdoor ratios; third box is really the population exposure calculation (as stated in figure title), include output as another box (maps, population distributions?); also would be helpful to include reference to Sections 3, 4 and 5 in figure for where described.

*AC : We would like to thank the reviewer for his/her suggestions to improve this Figure. We took them all into account (see Figure 1).*

2.4 Although details on methods are generally well described, the Monte Carlo sampling aspects are not clear. Some attention is needed in methods to more clearly describe when and how Monte Carlo sampling is utilized vs. when a modeled value is used.

*AC : We now add in sections 3 and 4 a sentence to explicitly state which variable is subject to random sampling.*

- *Sub-section 3.1 lines 187-188*
- *Sub-section 3.2.1 lines 245-250*
- *Sub-section 3.2.2 lines 272-273*
- *Sub-section 3.2.3 line 278*

### **3. Pollutant concentrations**

3.1 Modeled outdoor concentrations Model performance for the CHIMERE application (Table 1 and text) should include the number of measurement sites used and note the relative spatial coverage for each type of site.

*AC : The number of measurement sites is included in Table 1. A discussion on the relative spatial coverage of each type of site is now discussed in lines 145-150.*

3.2 Would be helpful to include Box plots showing the distribution of the statistics across sites in supplemental material.

*AC : This done in Figure S2 (supplemental material). The figure is discussed in lines 173-175.*

3.3 Fig 2: Text and figure title should note that figures are maps of specific date/hour. Suggest including maps of annual average concentrations in same figure with these of the example hours.

*AC : This Figure (now Figure 3) has been modified to address these issues. New panels with annual averaged surface concentrations of O<sub>3</sub> and PM<sub>2.5</sub> have been added. The corresponding text is also changed to note that left panels show surface concentration maps at specific date/hour (lines 176-177).*

3.4 Line 148-149: Also include box plots comparing the diurnal trend in modeled and measured concentrations or in supplemental material. Since activity patterns have a diurnal pattern, it is important to understand how well the air quality model captures the diurnal pattern in concentrations.

*AC : This new Figure has been added in section 3.1 (Figure 2) and discussed in lines 155-165.*

3.5 Line 151-153: is this adjustment what is described in 3.2.2 Transportation (Table 3)?

*AC : Model evaluation shows clearly that PM<sub>2.5</sub> concentration over traffic measurement sites are underestimated by the CHIMERE model by a factor of ~2. At this stage of development of EXPLUME, to assess this bias, we assume that when an individual travels along the road network or is in a car that passes through a road-tunnel we multiply the PM<sub>2.5</sub> concentration level by 2. We are currently working on the development of a subgrid-scale model that will account implicitly for these fine-scale effects. A more complete explanation of this issue is now given in lines 180-190.*

3.6 Unclear why units for ozone are micrograms/m<sup>3</sup>, when parts per billion (ppb) is typical.

*AC : The reason why ozone concentration units were in µg/m<sup>3</sup> is that AIRPARIF measurements are in this unit. We now changed ozone concentration and exposure units to ppb throughout the text. This applies to all figures and model scores (bias and RMSE) in Table 1.*

3.7 Indoor concentrations Fig 3: provide the actual distributions used as input to exposure calculations for all microenvironments in table similar to Table 3.

*AC : As noted in the paper (lines 257-262) these distribution are uniform. All information is therefore provided through the minimum and maximum values given in Table 3. We do not see how a Figure of these distribution would add value in the presentation of the model.*

## **4. Population data**

4.1 Line 243: add a concluding sentence that summarizes that Monte Carlo sampling method is used to randomly generate a data set of simulated individuals based on these steps

*AC : This sentence is now added in Section 4 line 289.*

4.2 Line 288: not clear why quotes are used

*AC : This was just a typo.*

4.3 Line 292-296: these could be a sentence list rather than bullet list.

*AC : This has been now changed (line 340).*

4.4 Fig 8: figure is small and should be enlarged. Or add a few other small plots showing different examples (children <4 vs. adults 25-64)

*AC : What we found more relevant here, is to add this figure as a panel to the previous figure (now Figure 8).*

## **5. Results**

5.1 First sentence should be improved to convey that each of the sections looks at a different aspect of the model output as examples of its use in applications.

*AC : We add this sentence at line 401-402.*

5.2 Line 354: add 'population' . . . "to provide population exposure maps"

*AC : OK (line 409)*

5.3 Line 369-370: sentence needs more explanation or refer to differences in indoor/outdoor ratios by age of buildings as done on line 361.

*AC : We explained this aspect more in detail in lines 424-427*

5.4 5.2 could be improved by including comparisons such as between male/female and/or age groups in Fig 10.

*AC : We added pie charts for different age groups to improve this section (Figure 10). The text has been modified to integrate the added information (lines 429-437).*

## **6. Conclusions**

Authors should compare/contrast the modeling approach or results with other similar work, e.g. Smith et al (2016) DOI: 10.1021/acs.est.6b01817, Shekarrizfard et al (2016) <http://dx.doi.org/10.1016/j.envres.2016.02.039>

*AC : We would like to thank the reviewer for providing these references. We now discuss our results in comparison to the findings presented there. This improved significantly not only the presentation of our conclusions but also the sensitivity analysis of section 5.4 that was directly comparable to these previous studies. We integrate this comparison in section 5.4 (lines 450-475) and in the Conclusions (Section 6 lines 510-530).*