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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Urban Aerosol Size Distributions: A Global Perspective" *by* Tianren Wu and Brandon E. Boor

Anonymous Referee #1

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This paper presents a compilation of observed particle size distributions in urban environments for many locations around the globe from the existing literature over the last 20 years. An important contribution of this paper is that the authors unified the many size distributions measured by different instruments to mobility diameter-based size distribution and fitted lognormal functions, providing the lognormal function parameters to be used for future studies. The paper also evaluates the implications for human inhalation exposure.

I think this paper will be a very useful reference for the community, since aerosol size distributions are so fundamental to the many science questions. To my knowledge, a compilation like this does not exist yet, so this paper fills an important gap. I commend the authors for their work and recommend publication after the following comments are

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Discussion paper

addressed:

Major comments: 1. The analysis focuses on the spatial variation, but since the data includes measurements over 20 years, there is temporal variation as well (i.e. particle numbers have decreased over the years in certain areas and increased in others, plus there are seasonal variations within a year as well). In other words, it is reasonable to assume that there is a lot of temporal variation within the data from a single site on various time scales. The paper doesn't mention these issues at all, but it needs to be discussed.

2. Another question is how representative the compiled observations are for urban environments in the different regions. One way to check this (at least for the US region) would be to construct a histogram of PM2.5 concentrations from the studies included here and compare these to EPA long term data.

3. Rearrange figures so that they are referenced in sequential order. For example, Figure 9 is referred to as the first figure in the paper, which is strange. This happens because the method description is separated out from the results, which is the usual way of structuring a manuscript. However, in this case, I think it would work to have one section (Section 3) about the "Geographical trends in size-resolved urban aerosol effective densities" which would include the methods and the results. Similar for the other topics covered. This would make the paper more cohesive and easier to read.

Minor comments: 1. Introduction: Mention the relevance of particle size for aerosol climate impacts. As global and regional climate models move to higher and higher spatial resolution, a compilation of size distributions in urban areas such as presented in this paper will be very useful.

2. A list of symbols and abbreviations would be helpful.

3. Section 3.1, eq. 1-4: What is the relationship of rho_eff and rho_p. Is to some extent mentioned later in eq. (6), but would be good to get this out of the way here.

4. p. 7, l. 12: The shape parameter is usually not used to characterize soot, but rather fractal dimension.

5. p. 7, l. 15: Complications in estimating rho_eff for coarse mode because of mixing state – I think the same can be said for the accumulation mode.

6. p. 7, l. 16: Avoid starting a sentence with a mathematical symbol. (This happens several times throughout the manuscript).

7. p. 9, l. 72: Notation: Is log referring to log10 or natural log?

8. p. 9, equation (7): Determining the number of modes to achieve best fit – how many modes are usually needed to achieve best fit? (i.e. is it mostly 3 modes or are sometimes more needed?)

9. Figure 1: Include abbreviation of different regions from the legend in the figure caption.

10. Tables 1 & 2: Include sampling frequency for the various studies or any information if the size distribution is an instantaneous snapshot or the result of a time-average.

11. Figure 5: Considering that the Aitken mode is only incompletely captured, the fit is doing some extrapolation. Mathematically, this is fine, but given that there is some noise, the fitted size distribution parameters could be way off. How reliable is the fit in such a case?

12. p. 17, l. 10: It would be helpful to include some references to papers where the issues mentioned here are considered and also give the reader some context about how important these issues might be.

13. Figure 17: Are the PSD assigned to UB and to TR significantly different (in a technical sense)? In other words, does the grouping into UB and TR make sense? Did you try to do a cluster analysis based on the PSD shapes to see what different types in terms of shape emerge (=size distribution regimes), and if they tend to include

size distributions from the same geographical region? Given the many factors that influence the shape of size distributions (as mentioned on p. 23), I question if the a priori separation into geographical regions is the best way to look at the data.

14 Section 10 and 11: It is not clear to me what the take home message is of these sections. This needs to be more clearly formulated and presented. To better gauge the differences in particle exposure for different regions, I recommend introducing a couple of integrated metrics, e.g. number concentrations of particles smaller than 100 nm/1 micron etc.

15. Data availability statement: Suggest posting an electronic version of the supplement to some databank (with doi) so that it can be easily used by the community for future studies.

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