

Atmos. Chem. Phys. Discuss., referee comment RC1
<https://doi.org/10.5194/acp-2021-515-RC1>, 2021
© Author(s) 2021. This work is distributed under
the Creative Commons Attribution 4.0 License.

Referee Comment on acp-2021-515

Anonymous Referee #2

Referee comment on "Technical note: Dispersion of cooking-generated aerosols from an urban street canyon" by Shang Gao et al., Atmos. Chem. Phys. Discuss.,
<https://doi.org/10.5194/acp-2021-515-RC1>, 2021

General Comment

This technical note deals with the spatial distribution of particles emitted from road traffic and from cooking sources in different vertical levels inside a street canyon. The PALM model coupled with the sectional aerosol dynamics model SALSA is used to determine the relevance of aerosol processes in a similar configuration as in Kurppa et al. (2019). From the analysis of time scales it is concluded that deposition mainly affects particles in the air close to the canyon surfaces, while the relevance of coagulation is related to the mean tracer age. Compared to Kurppa et al. (2019) the novelty of the present work appears to be the consideration of particles emission spectra from kitchen exhaust ducts, which have a higher fraction of small particles than emission spectra from traffic.

The presentation of the Methodology part should be better organized, in particular with a separate section for the emission scenarios. The emission scenarios need to be in one place early in the method section because all the result sections are referring to the scenario abbreviations. The validation section is confusing.

My main concern is that the time scale of mean circulation, i.e. residence time in the street canyon, of 380 s is very long in comparison to other published studies on street canyons. For example, Nikolova et al. (2014) report CFD simulations of aerosol particles for a real street canyon in Antwerp having unit aspect ratio and a dilution time scale of 110 s for low wind. Ketzler and Berkowicz (2004) give dilution time scales within a range of 45–120 s. The long recirculation cycle does not seem realistic even at low winds, hence leading to an overestimation of the contribution of coagulation to the reduction of mean particle number concentrations compared to the case with no aerosol processes.

The formation of a stable vortex holds for neutral conditions, but it needs to be tested what consequences unstable conditions with thermal convection have on the concentration

distribution in the street canyon. Another aspect to consider is that when the wind is parallel with the street, the recirculating structure within the cavity disappears completely, and the concentration field becomes very different. The authors should state such important limitations of the presented CFD simulations early in the text. Therefore, I suggest emphasizing that an idealized configuration of the street canyon was chosen, for the purpose of the study of particle emissions from different pollutant sources inside the street canyon. In conclusion, I believe that the paper should have a careful revision before publication.

Specific Comments

1.) Section 2.2.1: Provide more details on the configuration of the street canyon and mention which aspects are different to the street canyon simulated in the work of Kurppa et al. (2019).

2.) Section 2.2.2 has to be divided in a section on configuration of SALSA in this study and a section on emission scenarios.

3.) More details on the coupling of SALSA with PALM need to be provided. For example, are the particle emissions entering into the SALSA model or first into the PALM model? Deposition of particles: only to street surface or also and wall surfaces; in which distance from the surface are particles affected by deposition? Condensation of which gases?

4.) Section 2.3: the presentation of the validation is unclear. Several references to figures are missing. Maybe first mention what kind of validations were performed, then describe each test in a separate paragraph.

5.) P. 7 lines 148 - 153: explain the difference of the simplified computational domain used in the validation and the computational domain in K19. Is the simplified computational domain intended to mimic the real street canyon in Cambridge? I think Figure 5 belongs to this validation, but it is not referenced here.

6.) P. 13 line 2: Figure 8 shows only boiling. Where is the figure panel for isolated kitchens, deep frying? Figure parts fig. 8a and 8d are not referenced in the text.

7.) P. 14 lines 219 - 222: Time scale analysis for a street canyon in Cambridge by Kumar et al. (2008) reveals that dry deposition to road surface is much faster than deposition to wall surfaces. Can such a differentiation be made in this study as well?

8.) P.17 lines 254 – 256: The "plume-like structure" for case CO-D cannot be inferred from Figure 11. Should this refer back to Figure 7? It should be better indicated in the plot, how the plume like structure from column kitchen emissions develops.

9.) Section 3.4: it is not immediately clear where in the street canyon the aerosol number distribution were taken. If it is the canyon average distribution, then the standard deviations should be included in Figure 12. Where in the street canyon should measurements be done to be most sensitive to emissions of each of the different source types?

10.) Section 5.1: the description of the background particles needs to be improved. How is the background aerosol mixed into the street canyon - is the spatial distribution the same as for the emissions or is the background entering from the boundaries? Did the simulations take into account heterogeneous coagulation between the emitted particles and the background particles, or were they assumed to be of the same population?

Technical Corrections:

P. 7 lines 139: correct "ine Appendix B".

P. 14 line 229: deep frying?

26 line 431: delete "happens".

P. 27 line 440: delete "Jacobson and"

P. 27, equation (A.5): c is the particle mole concentration and thus should have index of particle-phase, not gas "g".

References

Ketzel, M. and Berkowicz, R.: Modelling the fate of ultrafine particles from exhaust pipe to rural background: An analysis of time scales for dilution, coagulation and deposition. *Atmos. Environ.*, 38, 2639-2652, doi:10.1016/j.atmosenv.2004.02.020, 2004.

Kumar, P., Fennell, P., Langley, D., and Britter, R.: Pseudo-simultaneous measurements for the vertical variation of coarse, fine and ultrafine particles in an urban street canyon, *Atmos. Environ.*, 42, 4304-4319, doi:10.1016/j.atmosenv.2008.01.010, 2008.

Nikolova, I., Janssen, S., Vos, P., and Berghmans, P.: Modelling the mixing of size resolved traffic induced and background ultrafine particles from an urban street canyon to adjacent backyards, *Aerosol and Air Quality Research*, 14, 145-155, doi:10.4209/aaqr.2013.06.0221, 2014.