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Comment on acp-2021-515

Anonymous Referee #1

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-RC2, 2021

Review of the manuscript "Technical note: Dispersion of cooking-generated aerosols from an urban street canyon" by Shang Gao et al.

The manuscript deals with the interesting and atmospheric relevant topic of the dispersion and processing of cooking and road traffic generated aerosol particles in urban street canyons. The authors address this topic using the building-resolving computational fluid dynamics model PALM, which also include the sectional aerosol dynamics module SALSA. The model was setup for an hypothetical and simplified street canyon with road traffic emissions or cooking generated aerosol emissions from the surrounding buildings. The authors address how the type, location and aerosol dynamics of the emissions influence the concentration in the street canyon.

Apart from a few typos and minor grammatical errors I think the manuscript is generally well written. I agree with reviewer 2 that it could benefit from some restructuring. Also consider if you need all 16 figures. After careful revision I think the manuscript has the potential to be publishing as an atmospheric relevant "technical note" in atmospheric chemistry and physics.

General comment:

What I mainly miss with the manuscript is a more careful motivation to the choice of the simplified (idealized) street canyon, the primary particle emission size distributions from the different emission sources, the meteorological conditions and the location of the cooking emissions, especially since the model is compared against real observations of wind velocity profiles from a wind-tunnel study (Figure 4), and observations from a specific street canyon in Cambridge (Figure 5).

No very much specific information is given about how the aerosol dynamics is represented in the model in the current study. Only the primary particle emissions are described, with some details. Especially I miss information about how the condensation of different vapors were treated in the model. E.g. what properties were assigned to the semi-volatile condensable vapors HNO_3, NH_3 and SVOCs.and how do you calculate their volatility with respect to the aerosol particle phase? For HNO_3, NH_3 is should depend on the aerosol liquid water content and acidity.

Specific comments:

Abstract, I miss one sentence which motivate why this study is important from an atmospheric chemistry and physics perspective.

L24-26, "Deposition is usually the only aerosol process included in urban CFD models as it is the most important for traffic emissions within street canyons (Kumar et al., 2011)." The reference to this statement is a bit old, is this statement still true? Also consider to replace "as it is the most important" with *as it is often assumed to be the most important loss process of ultrafine particles*. If you do not consider other process you cannot judge their importance. Hear you also only refer to loss processes and not formation processes such as atmospheric new particle formation which can be a major source of ultrafine particles also in urban environments.

Line 35-36, "There are strong reasons for expecting the dispersion of traffic-generated and cooking-generated aerosols to differ qualitatively." Consider to reformulate this sentence.

L37, "diameter of O(10 nm)" What do you mean with O?

L44 "The effects on the aerosol dynamic processes are highlighted" Do you mean *he effects of the aerosol dynamic processes are highlighted ?*

L56-57, "the inclusion of transient dynamics allows for nonlinear aerosol processes to be represented more accurately (see Sec. 5.2)." What do you mean with this statement?

L60-61, "Nucleation, which is computationally expensive to simulate, is not considered in this work." In which way do you mean that nucleation is computationally expensive to simulate? Usually nucleation is parameterized as a rate only depending on e.g. the H_2SO_4 concentration, or H_2SO_4 and NH_3. The concentrations of these vapors you anyway have to calculate in the model for the condensation growth.

L71-72, “semi-volatile (NVOCs) and non-volatile organics (SVOCs)”. It should be *semi-volatile (SVOCs) and non-volatile organics (NVOCs)*

L73, “however, chemical transformations are excluded.” What exactly do you mean with this statement? Did you not consider any gas-phase chemistry at all? If this is the case, please state this clearly.

L83, “The flow is driven by an external pressure gradient, dp/dx = -0.0006 Pa m^{-1}.” I cannot judge if this is a reasonable value. Can you add some information about typical values and a reference?

L109-110, “The emission factor for the number of particles emitted by a vehicle per unit distance travelled is 3.0×10^{14} km^{-1} veh^{-1} (Fujitani et al., 2020)” This, cannot always be a fixed value. At least replace “is” with e.g. “*was estimated to be*”.

L115-116, “The emission factors for the number of particles emitted per unit time by a kitchen of unit volume are $3.75\times10^{10}m^{-3}$ s^{-1} and $4.31\times10^{9}m^{-3}$ s^{-1}, for deep frying and boiling, respectively.” Replace “are” with e.g. “*were estimated to be*”.

Figure 3. The selected traffic emission spectrum from Janhäll et al., 2004 is relatively old. Is this still representative for the more modern car fleet today? I imagine that the fraction of nucleation mode particles may have gone up while the soot mode may have decreased with more modern cars? But, I may be wrong. Can you find any more recent references to at least compare with? Quite a lot of your conclusions are based on the selected size distributions of traffic, deep-frying and boiling emission size distributions.

Line 148-149, “Following K19, the coupled PALM-SALSA model is validated against evening measurements of the aerosol number concentration within a real street canyon in Cambridge, UK (Kumar et al., 2008). Can you really evaluate your model results against these observations? How similar are the Cambridge street canyon compared to your idealized street canyon. How does the meteorological conditions during the measurements agree with the neutral conditions with the temperature fixed at 300 K?

L151, “only are considered.” Change to *are only considered*

Figure 5, I miss a describing text and reference to Fig. 5 in the manuscript.

L169-170 “Deep frying (NG-D) and boiling (NG-B) yield identical concentrations in the

absence of aerosol dynamic processes. Please explain why this is the case. E.g. *Deep frying (NG-D) and boiling (NG-B) yield identical concentrations in the absence of aerosol dynamic processes because the location of the emission sources are identical.*

L175-176 "One possible explanation for this discrepancy is that the emission spectra differ:

the mean particle size is larger in the current study, i.e. 47.9 nm rather than 32.7 nm." This again makes me wonder about how representative the selected traffic emission spectrum is.

L176-177 "This is significant because smaller particles may have a larger deposition velocity" When you refer to small particles I think you mean submircon particles < 1000 nm in diameter. In this, case are not small particles (e.g. ultrafine particles) always having greater deposition velocities than larger >100 nm diameter particles?

L216, "Condensation has a negligible effect …" Does this not also depend on the model assumptions/limitations? Also evaporation of semi-volatile species from the fresh exhaust particles could potentially have large influence on the particle number size distribution, especially at the selected high temperature of 300 K. Some recent studies claim that particles can grow very rapidly by nitric acid an ammonia condensation, see e.g:

Wang, M., Kong, W., Marten, R. *et al.* Rapid growth of new atmospheric particles by nitric acid and ammonia condensation. *Nature* **581,** 184–189 (2020). https://doi.org/10.1038/s41586-020-2270-4.

Could the importance of such claimed rapid growth phenomenon be studied and verified or dismissed using PALM-SALSA?

L275 "O" What do you mean?