

Interactive comment on “Implementation of the sectional aerosol module SALSA into the PALM model system 6.0: Model development and first evaluation” by Mona Kurppa et al.

Anonymous Referee #2

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General comments:

This paper presents a novel modelling tool that couples a sectional aerosol module with a CFD based atmospheric driver. The model is used to simulate the measurements on the vertical variation of the aerosol number size distribution and concentrations in a street-canyon (Pembroke Street) in central Cambridge, United Kingdom, on March 20–21, 2007 (Kumar et al., 2008, 2009). The model represents the state-of-the-art in micro-scale air quality simulations and the results presented are of interest for the urban air quality research community. The only point that should be furthermore discussed by the authors are the limitations of CFD and LES approaches over neighbour-

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hood and city scale domains due to its large computational resources required for a single hour simulation. The authors should clarify what is currently the range of applications of this type of model. Its complexity doesn't make them suitable for the study of the urban scale air pollution if large computational resources are not available. The authors also state that emissions are a critical part to achieve realistic model results of size distribution. A discussion of the advantages and limitations of this approach should be included in the introduction.

Overall, the manuscript is well written and presents a novel approach to model size distribution of aerosols at urban scales. In my opinion, this paper deserves a minor revision to be published in Geoscientific Model Development. I recommend the authors to address the general comment and improve the manuscript following the specific and technical comments detailed below.

Specific comments:

- Page 1, line 6: the authors use qualitative comments to present the skills of the model like "excellent agreement with measurements" through all the text. The manuscript will be improved if such statements are accompanied by quantitative statistics.
- Page 2, line 6: please, add a reference to the sentence about Gaussian dispersion or semi-empirical street models limitations to represent urban complexity. More than the representation of urban complexity, such models have major limitations in the dispersion and to represent fine-scale flow processes.
- Page 3, line 3: it sounds contradictory to select an aerosol module initially designed for large scale applications. The authors should clarify the requirements needed for high-resolution micro-scale simulations and better justify the use of SALSA in the model approach presented.
- Page 3, line 6: the authors mention that the model is evaluated under different meteorological conditions, but in the manuscript, only neutral meteorological conditions are

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modeled. Please, correct this statement.

- Page 3, line 14: what "filtered" means in this framework?
- Page 3, line 23: the authors should quantify the sentence "Due to its excellent scalability on massively parallel computer architectures" or provide a reference.
- Page 3, line 29: what are the aspects that mostly affect computational expenses in aerosol microphysical modules? SALSA uses a sectional approach, which is not the best option to limit computational expenses in a micro-scale model.
- Page 3, line 30: the authors should justify the sentence "SALSA is equally suitable for presenting aerosol dynamics also at local scale". What are the requirements on aerosol processes in local scale models compared with large-scale models?
- Page 4, line 2: Are all the aerosols represented with 10 sectional bins?
- Page 4, line 3 and 4: Please, clarify that sulphuric acid, nitric acid, and ammonia can condense in the particle phase, and condensation is the only process forming sulphate, nitrate, and ammonium in the model.
- Page 4, line 17: Is the resuspension of coarse aerosols considered in the model? The authors should comment on the implications of excluding this process. Resuspension of particles by vehicles is an important emission source at the urban scale.
- Page 9, caption Table 2: the base case run should be included in the table to better understand the relative change in the total computation.
- Page 11, line 8: the authors have to include in Figure 3 or in a new figure the location of the measurements and indicate which are used to compare with the model.
- Page 12, caption Figure 3: were the observations taken at the same location as the red crosses? It is not clear in the manuscript where was the location of the observations.

- Page 14, line 4: how are the background profiles of aerosols ingested in the model and which size distribution is assumed? This may have a significant impact on the results of the model.
- Page 14, line 14: how is the turbulent kinetic energy initialized in the model? This is one of the critical points of LES models.
- Page 15, line 23: The authors mention that the modelled and measured values are hourly averaged. However, it would be quite interesting to see the histogram of measurements and simulation results during that hour. The high-resolution capability of the current modelling tool allows this analysis and it would provide interesting information about the skills of the model to reproduce the micro-scale features identified in the observations.
- Page 16, line 1: "compare well", the authors should quantify this statement. The scale of Figure 5 is semi-logarithmic which makes the differences with observations difficult to appreciate. Model results may be a factor of 2 or more overestimated compared with measurements. The authors should put in perspective this result. Are those differences reasonable when modelling number concentration?
- Page 16, line 2: "slight overestimation", the authors should quantify this.
- Page 17, line 1: "The rate of change of N_{tot} in vertical is correctly modelled except for a measured increase in concentrations within the lowest 2m". Can the authors discuss this? Is there a specific process that may explain this difference with the observations? Dry deposition would be the first process to consider.
- Page 17, Figure 5: It would be useful to plot the sigma of the observations together with the mean for the hourly average. This information would provide an idea of the variability within one hour observed in the area of study.
- Page 20, line 9: "there are no traffic related emissions of gaseous HNO_3 ". Why this has not been considered in the simulation? NO_x emissions are important in traffic,

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and they are a source for the formation of HNO₃. Its inclusion in the simulation may significantly increase the condensation of HNO₃ on the particles.

- Page 21, line 11: although the comparison of particulate mass could be not straightforward, it would provide some initial guidance on how uncertainty in number concentration affects mass concentration. A comparison of the model with the mass concentration of the observations would be quite interesting and an added value for the manuscript.

- Page 23, line 4: "good agreement", please quantify.

- Page 24, line 3: "no evaluation data were available". In section 3.4 and Table 4, the authors mention that the wind at 40m was adjusted to the observed one. This suggests that some meteorological data were available from the measurement campaign. Why this information is not used to evaluate the wind of the model?

Technical comments:

- Figures: all the figures have errors in the legend or letters used to identify the different panels. Please, make a complete revision of all of them and fix the problems with legends and letters.

- Page 1, title: please, specify the version of the module SALSA implemented.

- Page 2, line 25: correct "as an superposition" with "as a superposition".

- Page 3, line 7: correct "aerosol size distributions and chemical compositions" with "aerosol size distribution and chemical composition".

- Page 3, line 13: correct "an LES core" with "a LES core".

- Page 4, Table 1: correct "Is a surface scheme is switched on" with "If the surface scheme is switched on".

- Page 4, line 6: correct "Nitrates and ammonia" with "Nitrates and ammonium".

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- Page 5, equation 2: define "vc" in the text.
- Page 8, equation 10: define "LAD" in the text.
- Page 12, Figure 3: identify Pembroke Street in the map.
- Page 20: Figure 8 is not explicitly mentioned in the text, please do so or remove the figure from the manuscript.
- Page 22, caption Figure 10: correct "PM2.5" with "PM_{tot}".
- Page 23, line 19: correct "model cased by" with "model caused by".
- Page 23, line 21: correct "whereasthe" with "whereas the".
- Page 23, line 23: correct "observed concentrations" with "observed number concentrations".

Interactive comment on Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2018-282>, 2018.

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