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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Evaluation of a coupled dispersion and aerosol process model against measurements near a major road" *by* M. A. Pohjola et al.

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"The authors rely on particle number emission factors given by Gidhagen et al. (2004) and perform an extra sensitivity study using the emission factors reported by Yli-Tuomi et al. (2004). This is an acceptable approach. However, the authors should bring up more clearly in sections 3.1 (pages 2825 and 2826) that particle number emissions factors from vehicles are not well known and that they seem to depend on many factors related to both vehicles and environmental conditions. A good overview in this regard is the paper by Morawska et al. (2005, Environmental Science and Technology, vol 39, p. 9130-39)."

This is a good comment and will be allowed for in the revised manuscript.

"VOCs are not condensable into aerosol particles, but some VOC oxidation products may condense onto aerosol particles."

Yes, this is correct and will be written more specifically.

"The main result of the simulations presented by the authors is that dilution was the only important process affecting the evolution of the particle number size distribution in the simulated and that other processes were in practice negligible. This is quite an expected result and is apparently related to the prevailing conditions during the simulated days. On the other hand, other papers have been published where the role of coagulation and/or condensation/evaporation has been found to be important. The authors should explain why in most cases only dilution is important, whereas in some cases also other aerosol processes may become detectable. Clearly, all this is related to the relevant time scales of the processes involved."

It is correct that differing results on the relative importance of the aerosol processes have been presented in the literature, as these depend on ambient conditions. In this study, dilution seemed to be the dominant process in modifying the total number concentration, as in the cases reported here, the aerosol number concentration is fairly low and the dilution is not in any way inhibited (i.e., its characteristic time scale is relatively short); these conditions are unfavourable especially for coagulation. In our cases the time scales for self-coagulation of nucleation mode particles as well as inter-modal coagulation of nucleation mode particles with larger particles are longer than the time scale for dilution (see eg. Kerminen et al., Atmos.Environ., 41,1759-1767, 2007).

However, in conditions where dilution with cleaner background air is inhibited, and the exhausts accumulate in a restricted air space, as, e.g., in road tunnels (Gidhagen et al, Atmos. Environ., 37, 2029-2036, 2003) or during a temperature inversion (Kerminen et al., Atmos.Environ., 41,1759-1767, 2007) other processes, for example, coagulation, condensation and evaporation can also be important.

In our work, condensation was shown to have an effect on the size distribution. The

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discussion on these phenomena has been included in the manuscript in the Introduction with references to selected articles, where the role of other aerosol processes has been shown to be important.

Also, dilution may be a bit loose term to use here. What is meant by dilution includes dispersion of the original emission and mixing with ambient air containing urban background aerosol.

"Authors do not say practically anything about the role of stability or background aerosol in the simulated cases. Stability conditions seemed to be slightly different between the simulated three cases, could this be seen in the simulation results."

This is correct, the atmospheric stability changed during the four measurement campaign days, and the conditions grew more stable towards the end of the period. For the most stable cases, the simulation results were relatively less accurate. The sensitivity of the performance of the CAR-FMI model in terms of atmospheric stability has been studied against a substantially more extensive dataset in a previous study (Kousa, A., J. Kukkonen, A. Karppinen, P. Aarnio, T. Koskentalo: Statistical and diagnostic evaluation of a new-generation urban dispersion modelling system against an extensive dataset in the Helsinki Area. Atmos. Environ., 35/27, 4617-4628, 2001). In the above-mentioned study, it was found out that the modelling system tends to slightly underpredict the measured concentrations in convective atmospheric conditions, and overpredict in stable conditions. We have added a discussion on the effect of stability on the accuracy of the predictions in this study, and included a reference on the previous more extensive study about this matter.

Kerminen et al., 2007 have found that during an inversion situation, considering ultrafine particles, the role of self-coagulation was comparable to that of dilution for nucleation mode particles during rush hour, inter-modal coagulation had a moderate role, as well as smaller role of condensation (and evaporation). In stable conditions, the relatively slower mixing with background air is favourable for these aerosol processes.

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This discussion will be included in the manuscript.

“The rates at which the number concentration of particles in different “modes” decrease as a function of distance from the road is dependent on background aerosol size distribution. This should be mentioned and discussed as well.”

This is correct, as some aerosol modes originated from the traffic in the road are diluted less efficiently due to the same sizes being present in the background aerosol, while some aerosol modes are not present in the background aerosol.

As seen in Fig. 3, the median background particle size distribution has also two modes, and the mode diameters do not differ significantly from the corresponding ones measured on-road. In this work, background to on-road -ratio of aerosol number concentration is smaller for small (e.g. nucleation mode) particles and larger for largest particles. Unfortunately, the background size distributions were not measured simultaneously with the field studies on atmospheric dispersion.

However, we classified the measured time periods into three classes and calculated the medians over them; morning and afternoon rush hours at 7-9, at 15-19, and late evening at 21-23. The medians of particle number concentrations varied between around 11000 - 14000 cm-3; the highest value was observed during the morning rush hour when more accumulation mode particles were present, and the lowest during the night when also the nucleation mode diameter was somewhat smaller.

This discussion has been included in the manuscript in Chapter 3.2.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 2819, 2007.