

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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“Review of ‘Evaluation of a coupled dispersion and aerosol process model against measurements near a major road’ by Pohjola et al. (ACPD 7, 2819-2856) This paper, compares particle size distribution measurements near a road in Helsinki at several locations (with a mobile measurement station, at different times) and compares the results with a model with multimodal monodisperse approach.

I had the ‘pleasure’ of reviewing a similar paper (Hussein et al., ACPD 4001-4034) by partly the same authors, SUBMITTED THE SAME DAY. This paper described experiments conducted at the same location (but at different times), and modeled also with a combination of a aerosol process model (a state of the art one!) and a dispersion

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model (same as in this work). I really dislike this way of 'trying to maximise' the amount of papers. Both submitted papers have their flaws (but different ones) and would benefit a lot from combining. Still, there is practically no cross-referencing between these papers, and, actually the work by Hussein et al. isn't at all mentioned in this paper by Pohjola et al. The paper by Hussein et al. is much more thorough in describing the experimental results, and also, the modeling approach used (the sectional model UHMA) is more upto- date. However, this paper suffers from not knowing the 'initial distributions' at road side (instead, Pohjola et al. have estimations of the initial distributions). In contrast, an 'evaluation' of the cruder aerosol process model, as done in Pohjola et al., would really require a comparison to a sectional model such as UHMA. So my main question is, why did the authors not use the complete data set, and compare both models against this set (and especially with each other) ???"

We aim to resubmit this paper as Part I of a double paper. Part II will be the above-mentioned paper by Hussein et al. We aim to present more clearly the common points and differences of these two studies in the following (and of course also in the revised papers).

The emission estimates (including both the emission factors and the size-segregated chemical compositions) presented in the present paper (Pohjola et al.) has been used also in the modelling work that is presented in the paper by Hussein et al.. The same is valid regarding the methodology of source term dispersion modelling.

Regarding the experimental data, these two papers share one common location in the vicinity of the Itäväylä road. However, the Hussein et al. paper does not contain information about the change of aerosol size distribution as function of distance from the road, but only at one fixed distance. One of the leading ideas of the study Pohjola et al. was to examine the decrease of the aerosol number concentrations and sizes against distance from the road. In Pohjola et al., we also did not use the background concentration data measured at the station of Kumpula, which was used in the Hussein et al. paper.

The time periods studied were also different, Feb 2003 in case of Pohjola et al. and Aug-Sep 2003 and Jan-Feb 2004 in case of Hussein et al.. The meteorological conditions were therefore substantially different, leading to differences also in the vehicular emissions and background concentrations (both the size distributions and the number concentrations). Especially in the Northern European conditions, the seasonal variation of the meteorological conditions can be drastic.

The main approach and focus of these two papers is also different. In the Hussein et al. paper, modelling has a small role, since that paper focuses on the evaluation of the temporal variations and dependencies on local meteorological conditions of the measured particle number concentration and size distributions at the roadside, both of these compared with the urban background location. On the contrary, in Pohjola et al., modelling is the main issue, as the measurement dataset has already been presented and examined elsewhere (Pirjola et al. 2006).

As a summary, the papers do not address the same data, and therefore there is no complete dataset to be obtained by combining the data from these two studies.

In this paper (Pohjola et al.), we have used the monodisperse model MONO32 as an aerosol process model, partly due to the fact that as it has been used in our earlier work in the same area (Pohjola et al., 2003). In that paper, we studied effects of different aerosol dynamic processes (condensation, coagulation, dry deposition, dilution and mixing with the ambient air), when traffic particle emissions disperse in a local scale. A simple plume model was used, and comparison with measured data was very modest, due to the lack of appropriate measurement results. The presentation of these issues has now been improved in this paper in the Chapter 3.3.

We have added the comparison of the results of MONO32 and UHMA for Case 1 using the emission factors based on Gidhagen et al. (Fig. 7) and the value of $1 \times 10^{10} \text{ cm}^{-3}$ for the condensable insoluble organic vapour. Also Dr. Hannele Korhonen, who has made the new simulations with UHMA, has been added to the author list.

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As expected, the time evolutions of the total number concentration almost overlap (Fig. 7a) and also size distribution predictions by both models agree with the measurements. This has now been discussed and comparison of MONO32 and UHMA has been added in section 4.1-4.2.

Clearly, various aerosol dynamic models have advantages and disadvantages. The monodisperse models such as MONO32 are computationally more efficient than sectional models such as AEROFOR (Pirjola, 1999), AEROFOR2 (Pirjola and Kulmala, 2001) and UHMA (Korhonen et al., 2004). MONO32 is not subject to numerical diffusion upon condensation which might be a problem in sectional models. However, numerical diffusion can be reduced in sectional models by increasing the number of size sections or allowing diameter moving inside the sections (UHMA).

Both models (MONO32 and UHMA) can simulate the evolution of particles that consist of sulphuric acid, water, and ammonia, as well as an unlimited number of water-soluble organic compounds, and water-insoluble compounds such as mineral dust, elemental carbon and organic species. The same subroutines for aerosol processes are also used in both models. It is well-known that monodisperse models are not well suited for simulating continuous nucleation, where particles grow by condensation and self-coagulation. However, in this paper nucleation is not considered. The size distribution can be better represented by sectional models.

Now we will add in this paper the comparison of the results of MONO32 and UHMA for Case 1 using the emission factors based on Gidhagen et al. (Fig. 7) and the value of $1e10 \text{ cm}^{-3}$ for the condensable insoluble organic vapour. Also Dr. Hannele Korhonen, who has made the new simulations with UHMA, has been added to the author list. As expected, the time evolutions of the total number concentration almost overlap (Fig. 7a). The slight deviation might be due to the somewhat different subroutine when calculating the water content of particles. The size distribution by UHMA is slightly overestimated but still nicely compares with the measured results obtained by SMPS and ELPI (Fig.7b). Since in the monodisperse models all particles in each mode (N_i)

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have the same size which grows as a function of time, they cannot directly describe the lognormal size distribution. Instead, we have used the fixed mode limits given in Fig.3, and calculated $dN/d\log D_p = N_i/\log(D_p(i+1)/D_p(i))$ in these size sections, $1 \leq i \leq 6$. The base 10 was used. These results are also presented in Fig. 7b and as seen they compare well with the others. Of course, the monodisperse models cannot give detailed information of the nucleation mode particles, but this is also the case for many instruments such as for example, ELPI, which provides only two size sections for particles in the size range of 7 - 56 nm.

The size distribution representation has been changed also for the other cases (Case 8 in Fig. 8b and Case 11 in Fig. 9b) as explained above. This is possible as long as the mode sizes do not grow over the fixed mode limits, and this was the case when the condensable organic vapour concentration was 1×10^{-3} cm⁻³.

“Summing up, both manuscripts would really benefit from merging - this would in fact result in a really good paper. If, however, this is not the intention, my recommendation is to accept the paper by Hussein et al. with some modifications and reject the paper by Pohjola et al. (the reasons are listed below).”

Due to the different characteristics of the datasets (as described above) and different aims of these two works, we found it very difficult or even impossible to merge these two papers. This was also the view of the authors of Hussein et al.

However, we understand the motivation of the suggestions of the reviewer, and therefore would like to suggest to write a double paper. Clearly, the papers have in common the study of aerosol number concentrations and size distributions, and the same city and the same major road. Describing clearly the common characteristics and differences of the two studies in the suggested double paper, would in our view respond in the best possible way to the reviewers' suggestions.

“However, since the experimental results analysed in the paper by Pohjola et al. are somewhat more suitable for modelling purposes (in addition to knowing the initial dis-

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tribution, the far- from-road measurements are conducted at various locations) than the ones reported by Hussein et al., I am adding some more detailed comments in the following, to guide a possible later resubmission.

Major points: The authors main claims are that: 1. They couple a dispersion model (CAR-FMI) with an aerosol process model (MONO32)."

The coupling of the dispersion model and the aerosol process model presented in this paper is of "offline" coupling type. This is a valid comment, and we aim to present this matter more clearly in the text in Chapter 3.4.

"2. their model is 'evaluated' (title of the paper)."

We also agree that the title needs a revision in this respect, and it has been amended. Also, comparison of simulation results with the results from the aerosol process model UHMA has been added.

"The main conclusions of the work (in the abstract) are listed as: 3. Dilution is the most important process affecting the size distribution evolution."

It is correct that this is one of the conclusions, but it is clearly not the only one. Regarding total number concentration, dilution is the only process, the effect of which is found out, but it is also stated that an effect of condensation was found out for the smallest size modes; this is also a main conclusion and differs from the results obtained in our earlier work. The concentration of condensable organic vapour (Corg) in the exhaust gas, which is not known from any measurement data, could be estimated from the results obtained with simulations done using differing Corg. As far as we know, these are new findings. These points are brought forward in the Chapters 3.3 and the Conclusions.

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