

## ***Interactive comment on “Production, growth and properties of ultrafine atmospheric aerosol particles in an urban environment” by I. Salma et al.***

**I. Salma et al.**

salma@chem.elte.hu

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The authors thank Referee #2 for his/her detailed comments for further clarifying and improving the ACPD paper. We have considered all recommendations and revised the MS substantially. The most important alterations include:

- condensation sink, gas-phase H<sub>2</sub>SO<sub>4</sub> proxy and residence times for H<sub>2</sub>SO<sub>4</sub> vapour and freshly formed particles were calculated, and a whole new section (including a new figure and a table) on their importance, relevance and results was added, as requested by some of the Referees and the handling Editor;
- diurnal variation of particle number concentrations in two size fractions calculated

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separately for event days and non-event days were prepared, and the results were included into the interpretation as a new section including a new figure, as requested by one of the Referees;

- the section on mean number size distributions was substantially revised, new results and additional interpretation were included;

- further evidence was provided at many places in the text, e.g., to support that the Fig. 4b type contour plots are related to direct emissions, to explain the smaller time variation in daily mean number concentrations with respect to PM<sub>10</sub> mass concentrations;

- the statement on the presence of aged aerosol before new particle formation event starts (that was considered to be not fully justified) was completely removed;

- improved and explicit interpretation at several places with more detailed background information, firmer arguments and better explanations;

- Conclusions were reformulated substantially and were clarified.

We believe that the MS contains a large number of valuable information, and that its major weaknesses were all removed.

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## Response to Specific Comments

Response to Comment Abstract L17 The sentence questioned was removed from the Abstract and text.

Response to Comment P13691 L25 The suggestion was adapted throughout the whole MS without notes.

Response to Comment P13695, L10 The sentence on the prevailing wind direction and topography was reformulated.

Response to Comment P13697, L3 Individual number size distributions were only fit-

ted for specific days. Identification of nucleation mode was attempted and performed for days with new particle formation only, and, for these cases, the size distributions were fitted by three peaks. As far as monthly mean size distributions are concerned, the measured data were first averaged for each month, and the resulting mean size distributions were fitted. The text was modified now to include this information. It turned out in a recent comparative investigation that the median diameters of the accumulation mode for Prague, Czech Republic obtained by a different evaluation method are very similar to our results. The shift in median diameters with respect to rural or background environments may be a specificity of urban environments.

Response to Comment P13700 L17 A sentence was added on the seasonal variation of some criteria air pollutants in central Budapest. In addition, a reference for further details was also given.

Response to Comment P13700 L25 Identification and evaluation of the nucleation mode for non-nucleation days involve principal and practical limitations. At the same time, contribution of ultrafine particles to the total number of particles is a relevant property, which can be calculated for all days. In this way, we could determine the ultrafine contribution for nucleation and non-nucleation days. Their mean values were not significantly different from each other, which can be related to the fact that large emissions from road traffic and new particle formation events occur alternatively in Budapest (see Sect. Mean size distributions), which jointly maintain a more or less constant ultrafine contribution. The description was extended to include this aspect as well, and we also added a reference at this particular point to the latter explanation.

Response to Comment on fitted modal parameters Fitted NMMDs were extensively utilized for calculating the growth rates of nucleation mode particles. Other results regarding the modal parameters were included now into the text in Sect. Mean size distributions.

Response to Comment P13701 L10 The sentence was modified now to unambiguously

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express that it refers to the modal concentrations.

Response to Comment P13701 L18 Ultrafine particles have an electric mobility diameter below 100 nm. We were to express that the number of particles with a diameter smaller than 6 nm is negligible with respect to  $N_{6-100}$  (except for time periods of some hours after new particle formation events). We modified the sentence now to avoid any misunderstanding.

Response to Comment P13701 L23 The sentence was modified to express clearly that the concentration ratio in question is the ratio of the Aitken mode concentration to the accumulation mode concentration.

Response to Comment on P13702 An overview statistics was added to the text in Sect. Time evolution of size distributions concerning the representation of the contour plot types from 1 to 4, and Table 1 was also extended to include some further detailed information on this.

Response to Comment P13702 L5 The sentence in question was removed.

Response to Comment P13702 L9–11 Well developed nucleation modes only occur on days with new particle formation, and in these cases, the size distributions were fitted by three peaks. New particle formation events are associated with the nucleation mode, while traffic emissions contribute to the Aitken mode. The ratios – showing the importance of new particle formation events in terms of particle numbers – were determined for periods in which the nucleation mode was well separated from the Aitken mode, and hence effects of road traffic emissions could be excluded in this way. The text was modified to express this unambiguously.

Response to Comment P13702 L17 Nucleation mode could only be identified in daily mean number size distributions with large uncertainty mainly due to its shifting in time. Its modal parameters, therefore, were not used in further interpretations. Instead, individual size distributions were fitted, and time evolution of the nucleation mode param-

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eters very extensively evaluated further. The related sentence was modified to include these aspects.

Response to Comment P13702 L25–27 The sentence was modified to express that it is the particle number concentration that decreases in time in the late morning mainly due to decreased traffic intensity, and that it is the temperature of exhaust gases that is higher than the temperature of the ambient air.

Response to Comment P13703 L9–10 The interpretation was reformulated substantially. We provided some new results and evidences, and complemented the discussion to emphasize the importance of local circumstances and conditions for cities, and the need for further research.

Response to Comment P13704 L21 vs. P13705 L7 The statement on the seasonal variation of nucleation activity was based on the mean frequency for the four seasons, which showed a maximum of 44% in spring and a minimum of 7.3% in winter (and not in summer). The second sentence indicated this variation on a monthly scale, showing a maximum in April, and a secondary maximum in September. We do not see any contradiction here. Description of global causes for new particle formation events was substantially shortened. We prefer to include the interpretation and discussion of the reasons for new particle formation in Budapest into a new MS mainly considering the length of the present paper.

Response to Comment P13706 L23 The requested brief explanation was added as follows: “The larger summertime growth rates probably reflect the larger concentrations of condensable vapours due to enhanced photochemical activity, and also to increased biogenic organic precursor emissions. This is consistent with observations at other locations (Birmili et al., 2003; Dal Maso et al., 2005; Qian et al., 2007).”

Response to Comment P13707 L6–13 The text was extended to include this interpretation as a possible contributing explanation. Estimation of the spatial scale of new particle formation events is a very exiting issue, and it definitely needs further directed

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experimental work and modelling. Additional measurements have been going on at our measurement site as well in this respect. We reformulated the related part of the MS to emphasize that the present knowledge on this issue should be improved.

Response to Comment P13708 L1 The sentence in question was removed.

Response to Comment P13708 L9 We extended sects. Average atmospheric concentrations, Mean size distributions, and Time evolution of size distributions to express the arguments for the Conclusions explicitly. The rest of Conclusions was also revised and clarified.

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Interactive comment on Atmos. Chem. Phys. Discuss., 10, 13689, 2010.

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