

Interactive comment on “Measurements in a highly polluted Asian mega city: observations of aerosol number size distribution, modal parameters and nucleation events” by P. Mönkkönen et al.

P. Mönkkönen et al.

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Response for the referees' comments on manuscript acpd-2004-0099

Dear Editor,

We are thankful for the referees' comments and suggestions and they have been very useful in improving our manuscript.

Referee #1 - responses to comments

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General comments: According the referee #1 the major lack of the MS is that only 4 days are shown in more detail. In addition to the 4 days reported in more detail in the MS, we also show diurnal variations of modal parameters (table 2), namely the arithmetic (table 2) and geometric mean (30 min) diameters. However, as suggested we have added more data for the revised MS. In any case, the measuring period, in which the DMPS was used, covered from 26 October to 9 November 2002, not more or a less a whole year as referee might have thought.

The referee suggests focusing on new particle formation. However, we feel that both of the main streamlines (diurnal variation of aerosol number size distribution and new particle formation events) of the MS are important and relevant. In our study we present for the first time diurnal variations of number size distribution in a South Asian mega city. This part of the MS is useful for those who are interested in health effect of urban aerosols and air quality management (as mentioned by the referee #2).

The referee is hoping for a comment about long range transport. We have added “The effect of a long range transport to New Delhi’s climate from other polluted regions was studied with help of NOAA HYSPLIT trajectory Model. The analysis of the trajectories indicated low impact of other air masses to New Delhi’s climate during the measuring period.” to our revised MS.

Comments in detail:

Introduction We have reorganized our introduction a little. The removal of all references concerning traffic emissions and biomass burning would, in our opinion, make the paper weaker. We are thankful the referee for mentioning an important study conducted in Mexico City (Dunn et al., 2004), which we were happy to refer and compare our results to.

Methods More information of the buildings surrounding the measuring site is given in the chapter 2: “Other similar type of office building located next to IHC building, but there were only small individual private houses locating opposite of the IHC building.”

The referee also is hoping for some reporting about the wind speed and direction in relation to statements of stable conditions. However, we think that concluding the period as “stable” can be made also based on the stable maximum and minimum T and RH% data and also other observations (no rainfall).

The referee suggests that trace gases and PM10 concentration should be used to study diurnal evolution. Our trace gas and PM10 measurements were conducted by the time resolution of 4 hours. Hence, we have not used them in our study. Instead we have used modal parameters (number concentration, geometric mean diameter and geometrical standard deviation).

Radiosoundings were not available for the study.

Results We have added six other days to our MS. According the referee more explanation should be given in the text. We have discussed the substantial pollution event observed 4-5 November in detail before this MS (Mönkkönen et al., 2004b). Thus we added “The substantial pollution event observed 4 - 5 November (Day of Year 308-309) is reported by Mönkkönen et al., (2004b)” in chapter 3.1. We have also discussed the diurnal variations of number concentration by Mönkkönen et al., (2004a). To avoid overlapping, we have focused in our discussion in the diurnal variation of the size distribution.

The new particle formation events are summarized in the table 3 from which also the event starting time can be found. We have added a new figure (Condensation sink CS vs. time) for explaining the reasons for new particle formation events. In our opinion, CS is a better tool to explain the new formation events than the decrease of particle number concentration or NO_x before the event.

Figure 3 The referee suggests leaving some distributions away or change to color plots. We have shown the figure to several collaborators and arrived to the conclusion that the figure is clear enough to justify not leaving out essential (in our point of view) data.

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More discussion about diurnal variations regarding the figure is asked for by the referee. Thus we have added “The increase of GMD and number concentration of the particles towards the evening is discussed in the next chapter” to our MS to explain that the more detailed discussion of diurnal variations of number size distribution is given together with the modal parameters in the next chapter. We have also added “The decrease of accumulation mode particles after midnight could be explained by gravitational settling” to explain the decrease of accumulation mode particles in the early morning.

The impact of cooking in the evenings is discussed in the end of chapter 3.2.

Table 2/ Figure 4 Table 2 is an arithmetic mean of the whole campaign. We are thankful for the referee for noticing the clear errors in our Table 2 and Figure 4. We have corrected the minor mistake in our equation, which caused the clear errors for GMD and σ ; mentioned by the referee.

We have unified the time formats used to our revised MS.

The referee is worried that the clear particle growth from Fig. 2 is hard to find in Fig. 4. Fig. 2 and Fig. 4 cannot be directly compared since the Fig. 4 presents mean values of the whole measuring campaign.

Figure 5 We have left this figure out as recommended by the referee.

Figure 6 and 7 We have removed the day Oct. 28 from our MS and left only the day Oct. 29 to present an example of the new particle formation event. As stated earlier, we have added a new figure (Condensation sink vs. time) for explaining the reasons for new particle formation events.

Conclusions We have reorganized chapter 3.3 to point out more clearly the new particle formation event. Also more comparison for the other studies has been made.

We have softened our conclusion, which stated that “vehicular emissions together with biomass burning has significant contribution..” to “vehicular emissions together with

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biomass burning might have significant contribution..”

Referee #2 - responses to comments

Major comments 1. According the referee the main conclusion of diurnal pattern has been drawn from a period of 4 days. We disagree with the comment. Besides the period of 4 days (and the added 6 days to revised MS), our conclusion are based on the mean (arithmetic and geometric) values of the whole measuring campaign and closer analysis of a selected day (Oct. 28). The diurnal pattern of the number concentration is similar as reported by Mönkkönen et al., 2004a.

2. We have used the concept condensation sink (CS, see Kulmala et al., 2001) in our new particle formation analysis. We agree with the referee that solar radiation and total surface area of the pre-existing particles plays an important role in new particle formation event. However, we think that CS as tool is even better for this purpose. This is especially since when approaching accumulation mode sizes, condensation rates are proportional to diameter rather than area.

We agree with the referee the importance of the boundary layer and its influence on particle number concentration. This is mentioned in our previous paper (Mönkkönen et al., 2004a), but we have added the sentence “After the morning peak hour the number concentration decreases rapidly. This phenomenon can be explained by mixing within the boundary layer.” to our revised MS.

Minor comments 1. The referee suggests removing figure 1 without serious justification. We believe in its value and disagree. 2. We have revised our date formats, but we think that Day of year is also understandable. 3. We have revised figure captions. 4. Lines 12-15 have been revised. 5. We have added the sentence “The mean values are calculated from the whole measuring period” to the text. We have noted the time in the figure caption. 6. The changes in the number concentrations are well seen already in the log-scale. Changes in the linear scale would make the figure unbalanced. 7. Due to the cultural reasons, cooking is mainly done in the evenings. 8. Sentence has been

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rewritten. 9. We have removed the analysis during weekend and weekdays. 10. The sentence and terminology has been clarified. 11. We have not added the total number concentration at the start of the event to the Table 3 since, the CS has been the tool to analyze the starting time of the event.

Typing errors has been checked.

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