

## **General comments:**

In this study the seasonal variation of size distribution, mass, and chemical composition of ultrafine and submicron particles is investigated at an urban site in East Asia. Authors found seasonal differences in the particle size distributions: in summer Aitken and accumulation mode particle concentrations were higher than in other seasons, while the concentration of nucleation mode particles was lower. In addition, the mass concentration of ultrafine particles was observed to be highest in summer, and they were composed mostly of organic carbon. Sub-micron particles had the highest mass concentration in spring, and their major constituent was sulfate. Furthermore, new particle formation events were observed at the site during spring and summer.

I believe that this study is scientifically relevant and can be published in ACP after revisions. Authors should present some results on the diurnal variation of particle size distributions in different seasons. In addition, the structure of the “Results and discussion” section should be changed so that the paragraph on NPF events is not in the end of the section, and Table S3 should be moved to the main text. Furthermore, authors should show how high sulfuric acid proxy and low PM10 favor particle formation with some additional figures. The language of the manuscript should also be corrected (for example the tenses of verbs should be checked). Moreover, many of the figures are difficult to read because of too small size and/or low quality. More specific comments are presented below.

## **Specific comments:**

The title of the manuscript should include the information on the measurement site.

Page 21805, line 13: Newer references should be added here.

Page 21805, line 16: Here it would be good to refer to some of the review papers on particle formation.

Page 21806, line 6: The meaning of the sentence starting with “In a subtropical urban area...” is not clear for me.

Page 21807, line 20: Instead of “electrostatic mobility” a term “electric mobility” is more commonly used.

Page 21809, line 24: More details about trajectory calculations should be added. It is not clear if trajectories were calculated for each hour of the measurement period or less frequently. The arrival height of the trajectories should also be mentioned.

Page 21809, line 25: This paragraph should be moved to “Results and discussion” section.

Page 21810, line 22: Authors should explain more what is observed in Fig. 2 (how the size, surface and volume distribution change in different seasons).

Page 21811, line 1: Authors should refer here to the Table 1 where the ratios of concentration in different modes are presented, and also mention in the text what was the ratio for other seasons than summer.

Page 21811, line 6: It is not entirely clear what the authors mean by writing “a large number of nucleation mode particles could have been shifted into the Aitken and/or accumulation modes”. This should be explained in a more clear way.

Page 21811, line 20: If there are some previous studies where the mass of ultrafine particles has been measured in Asia, or in other conditions similar to the measurement site of this study, authors should refer also to those.

Page 21812, line 5: This sentence should be clarified, as it is rather difficult to understand.

Page 21812, line 16: This sentence should be revised as the annual average of PM1 is not actually presented in Fig. 3b.

Page 21813, line 19: Authors should refer here to Fig.1 presenting the trajectories for each season.

Page 21813, line 25: Authors should present in the manuscript (for example in this section) also figures showing the typical diurnal variation of size distributions in different seasons. For example, authors could make a surface plot (similar as in the bottom panel of Fig. 6) showing the median daily variation of particle size distribution for each season.

Page 21814, line 3: Authors utilize the difference between particle number concentrations during day and night to show if there is formation of new particles taking place in different seasons. However, it is not clear how other factors (e.g. boundary layer dynamics) affect the seasonal variation of that difference.

Page 21814, line 23: When calculating correlation coefficients between particle number concentrations and NO<sub>x</sub>, it would be better to first take logarithm of both variables and then calculate the correlation coefficients. Otherwise single data points can have too large effect on the value of the correlation coefficient.

Page 21815, line 10: Some numbers for the slope values should be given also in the text, not only in the figure.

Page 21815, line 13: It is not entirely clear what is meant by “demonstrate the size shift effects of particle growth”, so the sentence should be written in a more clear way.

Page 21816, line 5: Based on Fig. 6 the increase of PM<sub>10</sub> from 10 to ~100 μg m<sup>-3</sup> is at least partly related to diurnal variation, and not only to the change in the wind direction (after the change in wind direction PM<sub>10</sub> is still for some hours clearly above 10 μg m<sup>-3</sup>).

Page 21816, line 12: Authors should mention if there were there any new particle formation events during LRT events.

Page 21816, line 18: It seems that the difference is largest in the concentration of Aitken mode particles (N<sub>25-100</sub>). Authors should mention it and elaborate the reason for it.

Page 21816, line 20: Authors should mention if the value given for the wind speed is mean or median.

Page 21817, line 1: This section should be in a different place, not in the end of the “Results and discussion” section but closer to the beginning, as the observation of the frequency of NPF events helps to understand also other results (e.g. the seasonal variation in the composition of particles).

Page 21817, line 4: Figure 8 should be combined with Fig. 5 and discussed in the same section. Authors should first tell how often they observed NPF events during different seasons and then use the correlation with NO<sub>x</sub> only to support this observation.

Page 21817, line 12: Also some other references on particle growth rates could be mentioned here.

Page 21817, line 14: Table S3 should not be in the supplementary but in the main text because the information on growth rates and formation rates is relevant.

Page 21817, line 18: Authors should show that low PM10 and high sulfuric acid proxy favors new particle formation for example by studying their correlation with  $N_{4-25}$ , or then by showing their median diurnal variation for days with NPF events and days without NPF events. Showing only medians of these variables for different seasons is not enough for drawing conclusions about their importance for new particle formation. Authors could also study the effect of the air mass origin on the occurrence of NPF events by studying the air mass trajectories. In addition, authors should refer to some of the earlier studies where low condensation sink and high sulfuric acid concentration have been observed to favor NPF events.

Page 21818, line 24: It should be again explained in a more clear way what is meant by “shifting of the nucleation mode particles”.

Page 21827, Table 3: Condensation sink should be added to the table. In addition, the median values of UVB and  $SO_2$  should be shown separately instead of showing their product.

Page 21830, Figure 3: It should be mentioned in the caption if the values are seasonal averages or medians.

Page 21832, Figure 5: It should be explained if the data points in the figure are averages for a certain time interval.

Supplement, Table S3: This table should be moved to the main text. It should be explained in the methods section how the occurrence of NPF events was determined, and how growth rates and formation rates were calculated.

### **Technical corrections:**

Page 21806, line 7: The abbreviation (PNC) should be explained here.

Page 21806, line 24: The sentence starting with “To attain a better understanding...” is too long.

Page 21808, line 20: Use of slash (/) here might be confusing for the reader.

Page 21810, line 12: It would be better write “particle size distributions” than use the abbreviation.

Page 21810, line 13: The abbreviation (PNC) should be explained here.

Page 21810, line 15: The concentrations are written here in the wrong order (first should be the concentration in spring and then the concentration in winter).

Page 21810, line 24: The sentence starting with “It was relieved...” is too long.

Page 21811, line 11: It seems that “dominated” is not necessarily the correct choice of word here. Maybe “correlated” could be a better word.

Page 21811, line 22: The sentence starting with “For the chemical composition...” is too long.

Page 21812, line 24: “UPFs” should be “UFPs”.

Page 21813, line 12: “Maximal” and “minimal” should be “maximum” and “minimum”.

Page 21815, line 2: Use of slash (/) here is confusing.

Page 21816, line 10: Writing “particles stayed at a low level” would be better.

Page 21817, line 7: Instead of “remarkable NPF events” it could be better write e.g. “clear” or “strong”.

Page 21818, line 2: The abbreviations should be explained again here.

Page 21825, Table 1: It should be explained in the caption that the ratios between the concentrations in different modes are presented in the last columns.

Page 21828, Figure 1: Figure is too small; it is not possible to read the text in the labels on the right panel. It should be explained in the figure caption what the different colors in wind roses present. In addition, most of the other figures in the manuscript are also too small and include text with too small font and/or too thin lines.

Page 21831, Figure 4: Background of the figures should be white. The same applies to Fig. 8.

Page 21833, Figure 6: The color bar should be moved to the bottom of the figure. The color scale could be shown in logarithmic scale instead of linear scale.