

## Reviewer comment

# Sources and atmospheric processing of wintertime aerosols in Seoul, Korea: Insights from real-time measurements using a high-resolution aerosol mass spectrometer

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### Anonymous reviewer #1

#### General comments

This manuscript reports results obtained during a field campaign performed at Seoul, South Korea, during 6 weeks in winter 2015/16. The authors deployed an Aerodyne high-resolution time-of-flight aerosol mass spectrometer (hereafter the AMS) and several co-located instruments to measure the particle concentration, chemical composition, and size distribution. The authors performed the usual data treatment, including a source apportionment of organics by positive matrix factorization, a comparison of the different air masses impacting the sampling site with a back trajectory analysis, and a comparison of several selected periods (high vs. low loading).

The authors have a very interesting dataset in the hands, and all the information included in the supplementary material shows that the data treatment has been done very carefully. The manuscript is well written, and the content will be of high interest for the readers of Atmospheric Chemistry and Physics. I warmly recommend the publication of this manuscript after the authors address the following comments.

#### Specific comments

- 1) Section 2.2 “Measurements”: in addition to the five main species, PAHs results are also quickly given later in the Section 3. So I would suggest that the authors mention here that the total PAHs concentrations were also extracted from the organic mass spectra, with eventually some information on the related entries in the fragmentation table.
- 2) Page 10, lines 19-21: the authors quickly mention that new particle formation events were observed several times during this study. This is an important observation which deserves some additional discussion in the section 3.2 “Size distributions of the main components of PM<sub>1</sub>” (unless the authors plan to write a separate paper on this topic). In particular, it would be very interesting to use the pToF data of the AMS to identify which chemical species were involved in these new particle growth events.
- 3) Section 3.1.2 “Diurnal patterns of PM<sub>1</sub> composition”: I think it would be important to include here a discussion on the diurnal pattern of the wind direction. Indeed, according to Figure S11, the wind direction has a clear diurnal pattern, with a wind coming from the south during the day, and from the west during the night. Therefore, diurnal patterns of the different species discussed in this section seem not only driven by the dynamics of the boundary layer height or photochemistry, but also by a shift in the wind direction.
- 4) Page 13, lines 27-30: the authors claim that the size distributions of sulfate stayed fairly constant in concentrations and size distribution. Actually, this is not really the case, given that the concentration dropped quite fast between 9h and 14h (Figure 5b). I’m also wondering whether there is a discrepancy between the diurnal pattern of sulfate shown in Figure 5b (strong diurnal pattern, varying between 3 and 5  $\mu\text{g}/\text{m}^3$ ) and the hourly averaged size distributions shown in

Figure S4b, where the surface areas of the 24 size distributions look very similar (so no diurnal pattern observed here).

Then, they say that the size distributions of nitrate stayed relatively constant throughout the day as well. This is also not the case, given that the size distributions became much broader between 9h and 15h (Figures 5c and S4a).

- 5) Page 24, line 17: the authors say that during low loading periods, there was an enhancement of the fractional contribution of BBOA. Actually, according to Figures 12c and 12d, it is mainly LV-OOA which had an important enhancement (from 10 to 20%). In the same time, BBOA increased only from 9 to 12%.
- 6) Page 24, line 19: Actually, the authors had previously showed the high correlation between PAHs and BBOA, but they did not say anything about the link between PAHs and vehicle emissions. According to Table 2, the correlation between PAHs and HOA is much smaller ( $r = 0.48$ , vs.  $0.90$  between PAHs and BBOA).
- 7) Figure 14: clusters 1, 2, and 3 seem to come more or less from the same region in the northwest of the sampling site. It would be interesting to include in the supplementary material four maps (one per cluster) with the details of all the individual back trajectories included in each cluster. These graphs are easily generated by the HYSPLIT software and can show us whether a given cluster is the average of similar back trajectories, or whether back trajectories are completely different but give an average cluster coming from the northwest.

#### Technical comments

- 8) Page 3, lines 23-24: “on air pollution, as well”
- 9) Page 4, lines 16-17: “the mass detection of ~~submicron~~-non refractory submicrometer particulate matter (NR-PM<sub>1</sub>)”
- 10) Page 9, line 16: the authors mention that the ending location of the back trajectory analysis was at an elevation of 500 m. This is obviously not the case in Figure 14, where the ending location is at a much lower altitude than 500 m.
- 11) Page 12, lines 25-26: “could ~~to~~ be due to the dilution effect”
- 12) Page 13, lines 28-29: “constant in concentrations and size distribution (Fig. ~~S~~5b)”
- 13) Page 16, lines 4-5: the O/C ratios given here do not correspond to those reported in Figure 10(a-e) and Table S1 (neither to the Aiken-ambient method, nor to the improved Canagaratna-ambient method).
- 14) Page 20, line 29: “sulfate in Seoul ~~mainly~~-is mainly associated with regional sources”
- 15) Page 22, line 19: “Average O<sub>3</sub> concentration”
- 16) Page 23, line 5: “low RH (50 %), and long distance transport”
- 17) Table 2: if  $r = 0.70$  is the threshold for boldfaced values, please put the following value in bold:
  - C<sub>2</sub>H<sub>4</sub>O<sub>2</sub><sup>+</sup> (60) vs BBOA

On the other hand, the following value must not be boldfaced:

- C<sub>3</sub>H<sub>5</sub>O<sub>2</sub><sup>+</sup> (73) vs SV-OOA

- 18) The resolution of several figures (2, 3, 7, 9, S2, S3, S7) is quite poor. Please pay attention to this point during the submission of the final version of the manuscript.
- 19) Figure 1: the bottom right part of panel (b) is hidden by panel (c). It would be important to shift the different panels, so that we see the entire panel b with the locations of all the point sources of SO<sub>2</sub> (currently, we do not see those located on the southeast of the sampling site). BTW, it would be also interesting to mention in section 2 “Experimental methods” where the authors found all the information about the numerous point sources and their concentrations.
- 20) The title of the supplementary material is not the same as the one of the main manuscript.
- 21) Figure S1: in the panels (c) and (d), the labels of the left y-axes as well as those of the two colorscales are missing.
- 22) Figure S4: the legend of the y-axis of the panel (b) should be “dSO<sub>4</sub>...” instead of “dNO<sub>3</sub>...”.