

***Interactive comment on* “Effective densities of soot particles and their relationships with the mixing state at an urban site of the Beijing mega-city in the winter of 2018” by Hang Liu et al.**

Anonymous Referee #1

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This manuscript describes relation among density, morphology, and mixing states of aerosol particles containing soot. On the whole, the topic of the manuscript is relevant and suitable for the scope of the “Atmospheric Chemistry and Physics. The results taken from this study deserve to be made available to the scientific community and to be exploited in terms of atmospheric aerosols and atmospheric radiation budgets.

This manuscript is basically well-written and discussed carefully. I recommend that this manuscript is published in ACP after some corrections (as listed below).

1. Measurement procedures (Section 2.2) Aerosol particles were measured in the six steps using DMA-CPMA tandem system. In analytical condition, it took 10 minutes for

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each step (whole scan needs one hour). What is the response to achieve equilibrium in step change? Usually, data after equilibrium condition were used in the stepwise measurements to reduce analytical errors. In other words, data immediately after step change were not suitable for analysis.

2. Refractive index (Section 2.3.2) Refractive index of $1.48 + 0i$ was used for measurements of optical diameter. What is aerosol components with refractive index of $1.48 + 0i$? This information is helpful for readers who are not familiar with aerosol optical properties.

3. Line 177-180 Effective density of non-rBC with $0.8-1.2 \text{ g cm}^{-3}$ (blue, yellow, and red) was no $\sim 20 \%$ during EPs 1 and 5. The density was $30-40 \%$ during EPs 1 and 5 in Fig. 1.

4. Line 206-207 and Fig. 2 Figure 2 provides us very important and interesting knowledge on relation between aerosol size and effective density. Before detail discussion, influence of analytical error should be discussed. It is true that variation of refractive index can influence optical diameter. However, analytical error or analytical precision in the tandem system needs to be taken into account.

5. Line 247-250 R_{void} value (0.92) was shown in this sentence. In Figure 3, R_{void} of 0.92 seems to be too large. Is that typo?

6. Line 307-309 As shown in the text, insufficient detection limit can lead to disturb identification of detection of bi-modal pattern. Also, low analytical resolution in density may be one of the reasons.

7. Line 322-326 This difference between Eps 2 & 4 and Eps 1 & 5 is very interesting in comparison of ambient aerosols. Are there any differences in meteorological conditions, air mass history, and so on? What were important or key processes to engender the differences?

8. Figures 5-7 Analytical errors (i.e., error bars) should be added in the plots.

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