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## **Comment on acp-2021-463**

Anonymous Referee #1

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Referee comment on "Bimodal distribution of size-resolved particle effective density: results from a short campaign in a rural environment over the North China Plain" by Yaqing Zhou et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-463-RC1>, 2021

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**Interactive comment on "Bimodal distribution of size-resolved particle effective density in a rural environment in the North China Plain" by Zhou et al.**

General Comments:

In this study, a combined DMA-CPMA-CPC system was applied to characterize the size-resolved particle effective density in Multiphase chemistry experiment in Fogs and Aerosols in the North China Plain (McFAN) in autumn 2019. They identified a frequent bimodal distribution of particle effective density, and a unique low-density mode (named sub-density mode) accounted for ~20-30% of total observed particles. The diurnal variations of particle effective density and the influence of pollution and secondary aerosols were discussed. They concluded that the influence of BC on the effective density is even stronger than SIA.

Overall, the paper is well-written and is appropriate for ACP. The results clearly indicate the factors that govern the variations of particle effective density. The size-resolved particle effective density shown in the manuscript is interesting and would have

implications for further studies. Some minor comments are still needed to be addressed before the manuscript can be published.

### Specific Comments

1) The authors directly linked the sub-density mode to fresh black carbon (BC) emissions. Some organics might also have very low densities, which might lead to ambiguous conclusions. Previous measurements have also indicated that organics dominated in smaller size ranges. This is a key requirement when clarify the significance of BC in such mode.

2) It would be better to include uncertainty data when expressing the mean density in the abstract.

3) abstract: "...for the sub-density mode ( $\rho_{\text{eff,sub}}$ ) ascribed to the agglomerate effect." Does it refer to the agglomerate effect of BC?

4) Line 113: "A combined DMA-CPMA-CPC system was employed to measure the size-resolved effective density of particles with mobility diameter of 50, 100, 150, 220, and 300 nm" what is the uncertainty for the size selection?

5) Line 142-: It is necessary to show the uncertainty during the peak fitting with a flexible Gaussian fit algorithm, and thus potential contribution to the overall uncertainties.

6) Line 205-: "The remarkably high occurrence of the sub-density mode in our study indicates a frequent influence of local BC emission." Can these sub-density mode be matched to the variations of BC concentration?

7) Line 309: "It indicates that photochemical aging process is very efficient in transiting particles from fractal to compact morphology." In my opinion, the conclusion can only be obtained when the pollution during daytime and nighttime is at the same level. As discussed in the previous section, the pollution level over the study is highly varied, and thus the authors should compare the increase rate of  $D_f$  under the similar conditions.

8) Section 4.4: Is it possible to assume a diurnal variation of BC density for the test in Figure 6, according to the source's strength of BC?

9) The conclusions should be shortened to be more concise, in particular, there are several numbers that are not really important.