

Atmos. Chem. Phys. Discuss., referee comment RC2
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Comment on acp-2021-463

Anonymous Referee #2

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-RC2>, 2021

Dear Zhou et al.,

thank you for the interesting study regarding effective densities of ambient aerosol particles. The manuscript "Bimodal distribution of size-resolved particle effective density in a rural environment in the North China Plain" has been written very well and it is based on experiments conducted with state-of-the-art methods. The study presented in the manuscript aims to describe the effective density of ambient particles but also link it to the sources of particles, especially in case of observation of low effective densities. The figures of the manuscript are clear and mostly very informative and tables serve very well the structure of the manuscript.

One relatively important issue in the presented study is the duration of the measurement campaign. I think the experimental period is not long enough to generalize the results. Regarding to that, is it possible to modify the title and abstract so that this is brought out to readers already in the beginning of the paper? Mentioning that the study is "case study" or "short campaign" would be enough for that purpose.

As we all know, weather conditions have crucial role in aerosol formation, emission transportation and emission ageing, and they affect the ambient concentrations significantly. I propose that the authors include much more detailed weather data to the paper and investigate how the weather affect the effective densities of the particles. I think the affiliations of the authors enable the access to local weather data if it was not measured directly at particle measurement site. In addition, inclusion of the weather data into the paper enables better comparisons to other studies made later in same place or in other places by other researchers.

The authors mentioned some of the possible aerosol sources that can affect the aerosol

measured in their site. I would like to see those on map (e.g. roads, factories, power plants). In addition, to study their role in the measured aerosol, I propose that the authors analyze wind directions (if available) and add discussion about it to the manuscript. E.g. quite recent studies for coal combustion emissions have reported effective densities $>2 \text{ g/cm}^3$ for particles, and it could be interesting to know if that kind of emission sources are near the measurement site possibly contributing to aerosol measured.

In the experiment descriptions the authors write that they measured particle number size distributions also. It is not presented and analyzed in the manuscript. Why so? Could it be included into the analyses of size-resolved densities? In some previous studies made using SMPS-ELPI method the different densities have been connected to modes in particle number size distribution. It could be interesting and also important to see if this kind of results can be drawn from these experiments also.

The effective density of the particles can be affected by sampling method and treatment of the aerosol before the actual measurement. I would like short discussion in the manuscript regarding how the sampling and treatment used in this study possibly influence on the particle measured.

In the manuscript, the data have been divided to "polluted" and "clean" based on the PM_{0.7} results. How this PM_{0.7} was measured? Why these two were defined again in Figure 7 but now based on PM₁ and with different threshold value? If PM_{0.7} is based on SMPS measurements, what are the limitation regarding that (e.g. knowledge of fractal dimension)? And in my opinion, the data labeled as "clean" is not very clean air, and I propose using "less polluted" and "more polluted" instead of current terms. Furthermore, it would be interesting to know how these less polluted and more polluted periods exist in timeline of the campaign. Are they from diurnal variation of concentrations or from changes in general pollution level?

Technical questions and comments:

- There are no clear descriptions of the meaning of colour code used in figure S3. In addition, the units for the colour axes are needed ($\#/cm^3$).
- Why the colours changed from fig 1 (main density mode indicated by blue) to fig 2 (main density mode indicated by black) and to fig 3 (main density mode indicated by red)? In general, please check the uniformity of the article (text, definitions, figures)
- line 51: exits -> exist

Finally, thank you for the study which was made experimentally very well and which offered new insights to the characteristics of ambient aerosol. I hope that this kind of studies are made in future also in urban environments as well as directly for emission sources so that the the whole picture of aerosols affecting our health and climate can be understood better.