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Comment on acp-2021-1065

Anonymous Referee #3

Referee comment on "Different effects of anthropogenic emissions and aging processes on the mixing state of soot particles in the nucleation and accumulation modes" by Yuying Wang et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-1065-RC3, 2022

The manuscript investigates the daily and seasonal variability of soot particle mixing state coupling black carbon measurements and volatility tandem differential mobility analyzer data collected in a suburban site of the North China Plain (NCP).

The introduction reports that several other studies investigated the mixing state of soot particles using volatility measurements in the NCP. The introductions underlines that the present study differs from the previous ones because it encompasses two different seasons during a 5-month period. It is important to highlight what are the novelty of the results of this study compared to the previous ones, thanks to the multiple season measurements.

Some of the conclusions are not supported adequately by observations. Figure 4 shows that VV nucleation particles are characterized by a higher volatility during warmer months. On the other hand, the conclusion concerning the seasonal variability of nucleation mode soot particles relies on the assumption that nucleation mode soot is totally internally mixed. This assumption is not adequately supported by the presented results. For example, Figure 3 shows that nucleation mode particles are characterized by a multimodal distribution of SF, and soot could be responsible for the SV and NV peaks, which do not present the temperature trend discussed by the authors (higher values in warmer months). A deeper discussion of the results is encouraged. At line 441 the authors state that “Moreover, enhanced nocturnal liquid chemical reactions were responsible for the enhanced volatility of accumulation-mode soot particles in the nighttime.” No clear evidence of liquid or heterogeneous phase reactions during night-time is provided in this study to support such a statement. Furthermore, soot particle coating is controlled by condensation of vapor phase compounds and coagulation with other particles (Bond et al., 2013; Ko et al., 2020). The link between soot coating and NPF events is quite speculative and is not clear (line 274). If the author are interested in investigating such a link, the particle number in the range 10 -100 nm should be investigated, rather than solely the change in particle number concentration at 40 nm and 80 nm, as done at line 274.

Specific comments:

Line 166. Please specify if BC concentration was retrieved using the MAC suggested by the manufacturer or a site-specific MAC. In addition, the fact that BC is retrieved form optical measurements and the dependency of MAC on BC coating introduce some limitations in discussing BC concentration variability. The authors should mention this limitation in the discussion of results.

Line 228: It is not clear what the authors mean when they report the wavelength-dependent size resolved SF-PDF. It looks like figure 3 reports the SF-PDF for different particle sizes, as selected by DMA1.

Line 239 – 240: I suggest the authors to be more accurate, indicating that previous studies observed fresh BC in the lower bound of the accumulation mode. In fact, Levy et al. 2014 reports that the highest frequency of externally mixed fresh BC is observed at 150 nm, while Wu et al., 2017 reported that rBC size distribution measurements in Beijing peaked at about 200 nm, with a secondary less significant mode at 600 nm.

Paragraph 3.3.2 The statistical significance of the differences between day-time and night time observed in Figure 7 looks small. Could the authors comment on the observed variability?

Figure 10: Did the author explore a different type of fitting for the relationship between coating thickness (Dc) and PM_{10-400} (for example a logarithmic fitting rather than a linear fitting)?

Technical corrections:

Line 71-72. This statement is true in polluted environments

Line 115. A list of the measured meteorological parameters should be added to complete this sentence.

Line 137: The scope of DMA1 is to select particles with a specific mobility dimeter, thus it would be more accurate to write: "the water-based condensation particle counter (WCPC, model 3787, TSI Inc.), measuring the number of particles ranging from 10 to 400 nm.

Line 192: From Figure 2 it looks like in July wind from southeast was present instead of prevalent. Please revise the sentence accordingly.

Line 194: please specify when wind speed is considered high. From figure 2 it is difficult to understand if winds in August were stronger than in the other months.

Line 204: please add a reference for the assumed particle density.

Line 439: coating of soot takes place for condensation of newly formed material and not newly formed particles.

References:

Ko et al., Atmos. Chem. Phys., 20, 15635–15664, 2020

Bond et al., J. Geophys. Res.-Atmos., 118, 5380–5552, 2013