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Comment on acp-2021-433

Anonymous Referee #1

Referee comment on "Response of particle number concentrations to the clean air action plan: lessons from the first long-term aerosol measurements in a typical urban valley in western China" by Suping Zhao et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-433-RC2, 2021

This manuscript presents an analysis of long-term (7.5 years) particle size distribution, size-dependent number concentrations, and other related parameters at an urban background site (Lanzhou, West China) to study the influence of emissions and meteorology on the various particle size-modes. The long-term timeseries (Sept 2012–Aug 2019) also provides the opportunity to study the impact of China's ambitious efforts to reduce air pollution over the last decade. The authors use k-means clustering to classify hourly-averaged data from a scanning mobility particle sizer (13–800 nm) into six categories defined by specific sources and other influencing factors. Furthermore, the authors use a customized Sen-Theil trend estimator as described in Sun et al. (2020) to quantify the long-term trends of particle modes and other parameters. Overall, the findings suggest that accumulation mode particles decreased because of the clean air action. However, ultrafine particle concentrations increased as new particle formation clusters became more prominent. These findings have relevance for Lanzhou and other similar cities in China and around the world and highlight the importance of long-term measurements.

My specific comments:

- The analysis of long-term analysis of NPF and its frequency is incomplete without calculating and discussing the changes in the condensation (and coagulation) sink during this period — I highly recommend including this analysis. Furthermore, the authors could also calculate H_2SO_4 proxy (Dada et al., 2020) to estimate the changes in the NPF precursors over the study period.
- The authors separate the study into two contrasting periods (before and after Jan 2016). However, based on the timeseries in Figure 2, it seems that 2013 is an unusually polluted year even for 2012–2015 period. I think presenting the average particle size distribution surface plots for each year (by season) can be instructive for

highlighting the overall similarities and differences of each year of the study period (perhaps in the SI).

- Many of the graphics in the manuscript are well made and explain the central themes of the study well (e.g., I think Figure 4 is excellent). However, I think the readability of manuscript can be improved if some of the graphics that are supplementary to the analysis are removed or moved to the SI (e.g., Figure 3). Furthermore, some more details should be provided in the captions of the figures as they should be interpretable independent of the text (e.g., Figure 9 was not clear to me).
- Page 9, Line 4 ("The nucleation mode particles also can grow…"). I do not think this sentence is correct or required for this discussion. The timescales for such a transport (from ground to the sampling inlet) is likely to be much shorter than for the particles to grow from nucleation to Aitken mode.
- Page 17, Line 15 ("NPF events predominantly occurred under dry and sunny weather conditions"). This should be discussed with more nuance based on more recent literature. For example, according to a relatively recent review paper on NPF, "The observed factors that favor the occurrence of regional NPF include a high intensity of solar radiation, low RH, high gas-phase sulfuric acid concentration, and low pre-existing particle loading, i.e. low CS and CoagS" (Kerminen et al., 2018).
- For figures in manuscript or SI: (i) Include units of all parameters (where applicable); (ii) Avoid using captions such as "Same as Figure X, but for…"; (iii) Use continuous colorbars when using surface plots (Fig. 17 and Fig. S7).

References:

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