

Atmos. Chem. Phys. Discuss., referee comment RC3
<https://doi.org/10.5194/acp-2021-769-RC3>, 2021
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Comment on acp-2021-769

Anonymous Referee #1

Referee comment on "Interaction between aerosol and thermodynamic stability within the planetary boundary layer during wintertime over the North China Plain: aircraft observation and WRF-Chem simulation" by Hao Luo et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-769-RC3>, 2021

The study tries to distinguish the aerosol-PBL interaction of absorbing and scattering aerosols under contrasting synoptic patterns and aerosol vertical distributions. They use aircraft measurements model simulations to estimate the aerosol radiative effects over the North China Plain. In general, this manuscript investigated an interesting topic with ample analyses. A concept scheme is further summarized to describe their findings. However, the significance and representative of this study should be carefully discussed. This manuscript must address several major issues, before the potential publication.

Major Comments:

- Based on the model and aircraft data, this manuscript presents a case study for two days. It is questionable whether the conclusions from the case study are representative. The authors even draw a concept scheme from the case analyses. I believe the robustness of the conclusions needs to be carefully discussed.
- Only two cases of aerosol vertical distribution are discussed. However, the aerosol vertical distribution varies greatly case by case. It may not be feasible to discuss the impacts of synoptic conditions on the aerosol vertical distribution. It may not be valid to draw a meaningful conclusion about aerosol stratifications and absorptions based on the two cases.
- There are large diurnal variations in PBL. However, figure 6 only mentions the date. How about the specific time? As aerosol vertical distribution in figure 6 may not represent the daily condition, the authors need to address the diurnal changes in PBL and aerosol vertical distribution.
- After the case study, the manuscript presents the long-term variation in PBL thermodynamic stability. However, I feel this part is disconnected from the main

analyses. The long-term changes in PBL are affected by numerous factors. I did not find any useful conclusion from the analyses. The analyses also cannot conclude that "the inter-annual variability of the EAWM and SH can influence aerosol vertical distribution and ARE", which is cited from Section 3.4.

- Figure 14 seems to describe common sense. It is well-known that synoptic patterns, PBL thermodynamics, and aerosol vertical distribution can affect each other. What is the significance of Figure 14?
- Figure 15 tries to summarize the impacts of aerosol on PBL under different synoptic patterns. However, the "cold/warm advection" is only one factor and cannot fully represent the synoptic conditions. Four different scenarios are discussed but do not well support by their analyses.