

Comment on acp-2021-139

Anonymous Referee #2

Referee comment on "The effect of BC on aerosol–boundary layer feedback: potential implications for urban pollution episodes" by Jessica Slater et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-139-RC2>, 2021

General comments:

In this manuscript, a series of sensitive experiments were performed to reveal the impact on PBL thermal and dynamical structures by black carbon aerosol at different positions relative to the PBL height using a high resolution coupled large eddy simulation (LES)-aerosol-radiation model. This kind of topic has been addressed by a lot of studies, while it has been seldom focused by high resolution model, just as LES in this study. The authors highlight the different responses of PBL development to altitude of the aerosol layer in relative to PBLH, the initial strength of inversion, and BC heating rates. The analysis is mostly sound, but the results of model simulations need very detailed presentation, and some analysis need deeper explanation in physical and some conclusions need more robust supports. My specific suggestions are as follows.

Specific comments:

- There have been researches emphasizing the sensitivity of BC impact on PBL due to the BC positions relative to PBLH, which have not been viewed by this study, eg. Yongjing Ma; Jianhui Ye; Jinyuan Xin*; et. al (2020). The Stove, Dome, and Umbrella Effects of Atmospheric Aerosol on the Development of the Planetary Boundary Layer in Hazy Region. Geophysical Research Letters, 47, e2020GL087373. I wonder that any new findings in this study compare to previous studies.
- (LES)-aerosol-radiation model has been seldom used in this kind of 3-days long lasting events. I strongly suggest authors to present the detailed results of the LES simulations and the comparisons to observational meteorological factors of PBL and BC and BC related air pollutants profiles in PBL. It is the base and could be the advantage of this study.
- In the title and content of the paper, I feel the "Potential implications for Beijing haze episodes" could not give a direct and effective cognition to reader. If the mechanism is correct, it should be implicated to the BC related air pollution all over world. And this

study did not show the distributions and profiles of BC and air pollutants in Beijing.

- I don't understand the setting of the sensitivity experiments. In section 2, it looks like that the settings were a series of ideal sensitivity experiments of BC profiles, while in section 3, there were PBL changes in the specific days. When there were no observed BC profiles, we cannot know which setting was close to real profiles of PBL structures. If they are ideal experiments, why did you indicate the results were the specific days in Beijing?
- In figure 6, what are the reasons of the BC fluctuations in vertical direction and peak at around 300-500 in figure 6b-d?
- In line 305, "this can further increase surface concentrations if the aerosols at PBL top mix down to the surface." correspond to which figure?
- In line 381, "lead to a saddle type pressure field over the region which leads to a temperature inversion" correspond to which figure? If did not discuss in the manuscript, you cannot obtain the conclusion.

Technical corrections:

- Line 12, but decreasing across the PBL may but decreasing within the PBL;
- Line 65, (arund -> around;
- Line 161, we included an aerosol layer with BC at the surface-> we included an aerosol layer with BC near the surface;
- Line 167, "tropospheric lapse rates for 3rd Dec is more stable" is not a professional presentation;
- Line 171, " the same as BC surface", what is it mean?
- In equation 1, what is the interval of $t+1$ and t ? Is the eq. 1 right?
- Line 217 "There is slight subsidence of the aerosol layers", ??