

Review comments on “The impact threshold of the aerosol radiation forcing on the boundary layer structure in the pollution region” by Zhao et al., 2020.

1. The authors attempted to propose a parameter, $|SFC - ATM|$ for quantification of the impact of aerosol radiative forcing (ARF) on the atmospheric boundary layer (ABL) structure. Why did the author use the ARF of the interior of the atmosphere column (*ATM*) rather than the ARF in the ABL since most of aerosols or particulate matters are trapped in the atmospheric boundary layer?
2. Impact of ARF on reduction of surface-reaching short-wave radiation and heating/cooling of the atmosphere is dependent on not only aerosol loadings in the atmosphere (e.g., AOD) but also aerosol optical or radiative properties such as single-scattering albedo (SSA). What value(s) of SSA was(were) used in the numerical simulations with the SBDART radiation transfer model and how the threshold value changes single-scattering albedo (SSA)? It will be helpful if the author may provide more details about the configurations and inputs utilized in the simulations.
3. Is it necessary to use both virtual potential temperature gradient ($\frac{\partial\theta_v}{\partial z}$) and pseudoequivalent potential temperature gradient ($\frac{\partial\theta_{se}}{\partial z}$) to define the atmospheric stability since both have very similar time-height cross section distribution patterns? Please provide a description on how to use these two gradients to define the atmospheric stability and what are the advantages of using these two gradients rather than $\frac{\partial\theta}{\partial z}$ in determining the atmospheric stability?
4. Figs. 2-3: It is suggested to replot these figures by including specific months and dates in x-axis for a better view. In addition, right y-axis should be $PM_{2.5}$ rather than PM for both figures. Please correct them.
5. Fig.3a: Usually, higher $PM_{2.5}$ concentrations, lower surface-reaching shortwave radiation, and weaker turbulent activity (i.e., lower TKE). However, such a relationship is not clear in the ABL on day 1 for Episode II and day 4 for Episode III.
6. L250-251, For the statement of “the atmospheric stratification during Episodes I and II was altered” , please provide specific calculation to illustrate how the stratification was altered”. Similar statements were also found in several places in the manuscript.

7. Fig.4: It is difficult to understand that aerosol radiative forcing at top of the atmospheric column (TOA) has so close relationship with surface $PM_{2.5}$ concentrations. Please provide an explanation. Again, it is better to calculate the ARF for the integrated ABL rather than the interior of the atmospheric column.
8. Why did the authors use the absolute value of difference between SFC and ATM? Why not use $ATM-SFC$ since ATM is positive and SFC is negative? In fact, the $ATM-SFC$ represent a combined impact of aerosol radiative effect on surface-reaching shortwave radiation and the atmospheric layer. It is not surprised to see $ATM-SFC$ increases with increasing $PM_{2.5}$ concentrations (see Fig.4d). Here the authors still use scatter plots to quantify the relationship between aerosol radiative effect and surface $PM_{2.5}$ in terms of model results. Are there any observational data available to verify the results?
9. Fig.6: Please add a), b), c), and d) each panel, respectively, and specify clearly in the figure caption.
10. L87-91: This is definitely not true if the authors claimed that “this paper is the first time to analyze the interaction between”. Many studies have devoted to understanding and quantifying the interactions between aerosol radiative effect and the atmospheric boundary layer thermodynamic and dynamic structures up to now. Some examples include Zhao et al., 2019, Zhang et al., 2020, Miao et al., 2020, Liu et al. 2020, etc.
11. Line 510: Again, this study is definitely not the first one. Please delete any statement like this.
12. L15: I am very concerned with the statement with “...because most studies have been superficial”. Please delete or modify it.