Reviewer #1

The authors aim to investigate the complicated impacts of synoptic forcing and aerosol radiative effect on boundary layer and pollution in the Beijing-Tianjin-Hebei region of China. The manuscript has well-presented some findings. However, there are still some minor concerns that need to be addressed.

Thanks for taking time to review our manuscript and offer helpful suggestions! We carefully revised the manuscript, please see the response below.

1. Most of all, more deeper analyses are needed for all of the figures. In the current version, the analysis is too simple and rough for the figures. Besides, a mechanism analysis should be performed according to the phenomena.

More analyses and discussions were added for most figures as suggested. For the associations between synoptic pattern and PBL structure, more meteorological parameters (e.g., temperature and relatively humidity) were compared and analyzed. In addition to the synoptic Type 2, the impacts of Type 4 on PBL and aerosol pollution were also elucidated based on the long-term soundings and $PM_{2.5}$ measurements.

Besides, instead analyzing those two episodes roughly, in the revised manuscript we focused on the pollution episode at the end of December 2017 and tried our best to unravel the links among the evolution of synoptic conditions (i.e., Type 4 on December 27, Type 2 on December 28-29, Type 1 on December 30-31), PBL structure, pollutant transport, as well as the aerosol radiative effect. The possible mechanisms related to the development of PBL were carefully given based on the abovementioned observational and simulated analysis.

2. In the Abstract section, Line 10-15, the meaning of "To unravel the complicated impacts of large-scale atmospheric forcing and the local-scale planetary boundary layer (PBL) characteristics on the pollution there" is unclear. Moreover, the title illustrated that the focus of this study is the "impacts of synoptic forcing and aerosol radiative effect on boundary layer and pollution". The Abstract needs more improvements.

The sentence mentioned were rewritten as:

"The heavy aerosol pollutions frequently occur in winter, closely in relation to the planetary boundary layer (PBL) meteorology. To unravel the physical processes that influence the PBL structure and aerosol pollution in BTH, this study combined long-term observational data analyses, synoptic pattern classification, and meteorology-chemistry coupled simulations."

Since more analyses were added, most of the abstract were re-written.

3. What is the standard to identify the heavy pollution episodes in Figure 2?

The heavy pollution episode was identified when the maximum daily $PM_{2.5}$ concentration is greater than 100 μg m^{-3} in both Beijing and Tangshan. The relevant information was added in the figure title.

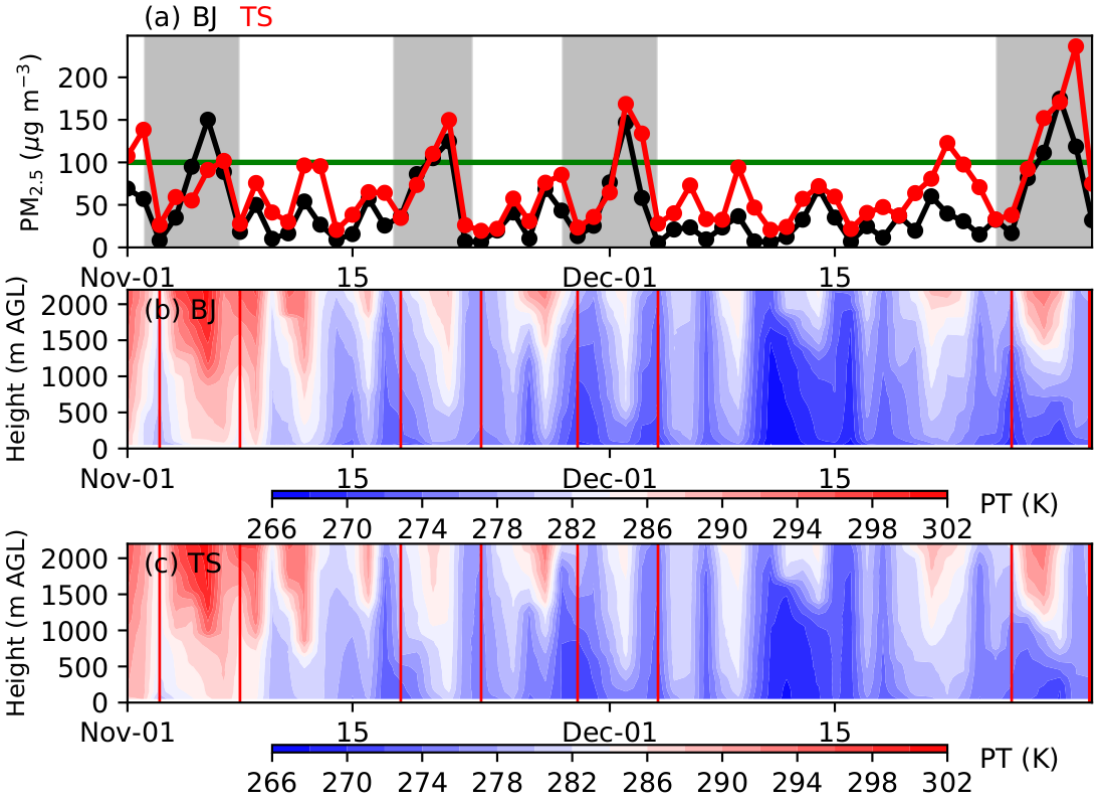

Fig. 2. Time series of observed $PM_{2.5}$ concentration from 1 November to 31 December in 2017 in (a) Beijing and Tangshan, and (b, c) the vertical structures of potential temperature (PT) derived from the sounding data at 2000 BJT. Four heavy pollution episodes with maximum daily $PM_{2.5}$ concentration greater than 100 μg m^{-3} in both Beijing and Tangshan are marked by the grey shadings in Fig. 2a.

4. The abbreviation should be used in the following illustration after definition.

Thanks for your kind suggestion. The definitions of abbreviation were added in revised manuscript, and some abbreviations were removed (e.g., ROI).

5. Section 2 should be separated the two parts including “Data” and “model description”.

The Section 2 was separated as suggested.

6. In Figure 6, the legend should be given in (a).

Revised as suggested.

7. Figure 7-9, are these results the model simulation or reanalysis results? It should be present clearly in figure title.

All these figures presented the model simulations. The information was clearly stated in the figure titles as suggested.

8. The black line in Figure 7 is not clear.

In the revised manuscript, we reorganized the manuscript and removed the Figure 7.

9. In Figure 8-9, what is the meaning of gray color shading? In Figure 10a and 10b, what does the white color denote?

The grey color shadings in Figs. 8-9 denote the mountains. In Fig. 10a and 10b, the white color also denotes the mountains. In the revised manuscript, all the mountains were denoted by the grey shadings and clearly stated in the figure titles.

10. Page 5, Line 151, the sentence “As the estimated BLH shown in Fig. 5” need to be rephrased.

In the revised manuscript, the sentence was revised as: “Fig. 5 shows the time series of simulated BLH in Beijing and Tangshan.”

11. What is the meaning of “region of interest”? Some abbreviation is not needed. For example, ROI.

The “region of interest” is the region we primarily focused on. To be clear, in the revised manuscript, the abbreviation was removed as suggested.