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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The dynamic-thermal structures of the planetary boundary layer dominated by synoptic circulations and the regular effect on air pollution in Beijing" *by* Yunyan Jiang et al.

Anonymous Referee #2

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To date, the fine-resolution structures of thermodynamic and dynamic properties of the PBL remains poorly quantified, which in turn impairs our understanding of the formation mechanism of frequently occurred air pollution episodes in developing countries like China and India. The manuscript by Jiang et al. revealed detailed dynamical-thermal structures of PBL in Beijing-Tianjin-Hebei region of China based on the atmospheric profiles from a variety of ground-based remote sensing instruments, meteorological measurements from AWS, and reanalysis, combined with objectively classified synoptic patterns. A novel mechanism considering the synergistic effect of synoptic pattern

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Discussion paper

and PBL is proposed, which makes sense to me. The analysis methods are scientific sound, and the manuscript is well organized. Nevertheless, some of the results interpretations are not crystal clear, several conclusions drawn here can not be adequately supported by the results. Therefore, this work has to be returned to the authors for revision before it can be accepted for publication in ACP. My comments are listed as below.

Major comments: 1. Section 2.2. There are several ground-based remote sensing instruments used here. The retrieval of atmospheric thermal and dynamic variables will inevitably incur some kinds of uncertainties or even errors from these instruments. Nevertheless, I can not find any discussion on the uncertainties. 2. Section 2.3: How many PM2.5 data were used for the classification of synoptic pattern? And what is the spatial distribution of 68 PM2.5 monitoring stations? both of which should be clarified in this part. 3. Section 2.4: the authors are suggested to make it clear what kind of measurements has the Richardson number method been applied to? 4. Figure 12 & L377-381: Divergence profile and vertical velocity show large difference. For instance, the lower troposphere dominated by convergence at all times of day, while only during daytime the vertical velocity is positive (does the negative value denotes updraft? Please clarify it in Figure 12 caption). The authors may explain the discrepancy between the profiles during different times of day for vertical velocity and divergence. Besides, “900 hPa” is not exact, either. 5. Figure 13 & L402-403: the regional breezes within the PBL is generally observed in daytime instead of nighttime, so I am curious of how the mechanism (cold air mass induced by breeze overlaid by warm advected air) work out in BTH during nighttime? Regarding the schematic in Fig. 13, PBLHtop and PBLHlow are not logically right, and can be revised to PBLtop and PBLlow. Besides, this schematic should focus on the BTH region where the findings apply only from this work.

Minor comments: 1. L37-38: “are dominated” -> “dominate” 2. L49-52: One important factor, PBL and its interaction with aerosol, is missing for accounting for the

frequently occurred atmospheric pollution episodes. This is relevant to the topic of this study. The author may consider citing the review paper by Li et al. 2017 (doi: 10.1093/nsr/nwx117) and related observational studies such as Ding et al., 2016 (doi:10.1002/2016GL067745); Lou et al., 2019 (doi:10.1029/2019EA000620), Petaja et al. 2016 (doi: 10.1038/srep18998), among others. 3. L63: “on”-> “to” 4. L85-86: “which acted as a lid and capped the pollution in the boundary layer” needs reference support, the authors can refer to Xu et al. 2019 (doi:10.1016/j.scitotenv.2018.08.088) 5. L115: “observation data provided”->”weather station operated” 6. L256: it is inappropriate to say “meridional winds turned to easterly”. First of all, the authors are suggested to make it clear the meridional wind is northerly or southerly. Secondly, the horizontal location in Figure 5 and vertical location in Figure 6 are suggested to be clarified. Last, the hours or time should be specified as well. Otherwise, the authors can not well follow what the authors are talking about. 7. L256: ”advective temperature inversion occurred from 600 to 900 m (Fig. 6d)”: I can not see any temperature inversion layer located within 600 – 900 m a.g.l.. If my understanding is right, the temperature inversion only occurred at 08-09 LT on October 22 and early morning (00-11) of October 23, but not at altitudes ranging from 600-900 m. 8. L256-257: Again. I am confused with “accompanied by stable stratification (Fig. 6e)” . Please clarify when and where stratification occurred. Can you directly identify a stratification layer from Fig. 6e. Probably the authors need to expand the description and give a more clear interpretation with Fig. 6e. 9. L441: grammar errors in “On the other hand, regulate”

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