

Review comments on the manuscript ACP-2019-758 submitted by Yu et al.

General comments.

In this manuscript, the authors present an observational analysis to characterize the unique features of meteorological conditions that account for the heavy air pollution events in Wu Han, a metropolis in the Yangtze River Middle Basin, China, and then use a Lagrange particle dispersion model to quantify the percentage contribution of regional transport to such heavy pollution events. They found that $PM_{2.5}$ concentrations show a positive correlation with wind speeds and no stable atmospheric boundary conditions are required to support the accumulation of air pollutants when 24-hr average $PM_{2.5}$ concentrations are higher than $150.0 \mu g \cdot m^{-3}$.

Regional transport driven by strong wind speed contributed more than 65% increase in surface $PM_{2.5}$ concentrations during the development of air pollution events in this region. The study represents a great interest to air quality community given the unique features which are very different from those presented in the textbooks. This version is improved to some extent as compared to the first submission. Part of my comments have been addressed but not all.

Especially, the manuscript structure is not re-organized as suggested, a lot of grammar errors or typos need to be corrected throughout the manuscript. In addition, I have several major concerns with the authors' arguments during their analyses and discussion. Thus, a major revision is still required before it is accepted for publication.

Major comments

1. It is strongly recommended to re-organize the structures of the manuscript. Both Methodology and Results/Discussion parts are mixed together in the current version. So it is suggested to move "Model Description (Section 3.2.1)", "Model Configuration (Section 3.2.2)", and the way of calculating "contribution rates" (Lines 360-375 in Section 3.3) to a new section like "Data and methods"(say Section 2 in the new version), and then move part of current Section 2.1, Sections 2.2 and 2.3 to Section 3 like "Results and Discussion" in the revised or new version something like that.

2. The East Asian winter Monsoon were mentioned at least 10 times throughout the manuscript to highlight its importance in driving the regional transport during development of heavy pollution events observed in Wuhan. As we know, the East Asian Monsoon represents a seasonal mean behavior and its temporal scale is much longer than that of air pollution events which usually have a scale of one to several day(s) but not longer than one week according to the authors' argument. The authors need show some scientific evidences to support their arguments on how the East Asian winter Monsoon can drive the regional transport which may lead to the development of heavy pollution events. Otherwise, the readers may get confused when they read Fig.9b in which the regional transport was from East China other than North China. My suggestion is to limit the emphasis of the East Asian winter Monsoon in this study.

3. Estimate of percentage contribution of regional transport to the heavy pollution events in the YRMB region is one of the major works proposed by this study. As described in Eqs. 1 and 2, simulation of residence time of $PM_{2.5}$ is critical to conduct such calculations. Please define residence time. How does the FLEXPART simulate the residence time? A little bit more details are helpful for our readers to understand the percentage contribution of regional transports to the three different episodes.

4. Lines 323-329: I assume that the FLEXPART simulations were driven by the WRF outputs rather than ECMWF or NCEP reanalysis data. If this is the case, please make clarification and delete lines 323-325.

5. Fig.5b: We can see that the heavy air pollution events had stronger winds within the 1-km layer but weaker winds above the 1-km layer as compared to that light air pollution events. Does this mean that regional transport is mainly limited to the 1-km layer? Some discussions on this will be helpful.

6. Writing needs a heavy edit work. There are a lot of grammar errors or typos and many sentences need further improvement. Some of examples include “obviously differences (L107)”, “relative high (L109)”, “suffering under significant (L133)”, “has significantly influence (L162)”, “relatively to (L276)”, “a horizontally resolution (L344)”, etc. I am not going to list all of them since there are many.

Minor comments:

1. L19: central China → Central China.
2. L20: I am not sure “excessive” is appropriate in this manuscript.
3. L30: I did check “List of regions of China” at Wikipedia at https://en.wikipedia.org/wiki/List_of_regions_of_China, and didn’t find “central-eastern China”. So “Central China” should be better and sufficient.
4. L33: FLEXPART-WRF or WRF-FLEAPART? I would suggest the latter since it is WRF-driven FLEXPART. In addition, please define any abbreviated terms at its first appearance. Please check similar issue for other abbreviations throughout the manuscript.
5. L155-157: Please define these abbreviations at their first appearances.
6. L251: change “the atmospheric stability in the boundary layer” to “the stability of the atmospheric boundary layer”?
7. L261-262: Please change “is generally accepted” to “are generally accepted”.
8. L272: Are you sure “it is in Section 3.1”?
9. L287: Please add “the” before “YRMB”.
10. L342: Please change to (30.61°N, 114.42°E).
11. L232-235: I feel a “jump” when I read this sentence.
12. L352: “The simulated meteorology” → “The simulated meteorological fields”.
13. L373-374: Change “by calculation of the $PM_{2.5}$ contribution rates with Eq (1)” to “by using the $PM_{2.5}$ contribution rates calculated with Eq.1” something like that.

14. L309-313: I do not think this paragraph is necessary since it does not provide any useful information. Similar issue can be found in other places of the manuscript.
15. L338-339: What are the horizontal resolutions of the NCEP reanalysis data?
16. L419-423: Does this paragraph represent any significant findings or conclusions obtained from this study? I am not sure including this paragraph is necessary here.
17. L424-426: We know this already and I don't think you need iterate this sentence here. It does not provide any more useful information.
18. L625-629: Please define WS, T, P, and RH in the description of Table 1 and Table 2.
19. Fig.1b: The font size of those cities shown in Fig.1b is too small. Is it possible to add the locations of 10 sites presented on Page 5 at Lines 101-103 in this plot?
20. Fig.9: I believe that the values of the percentage contribution rates are not correct.