

## ***Interactive comment on “High Time Resolution Source Apportionment of PM<sub>2.5</sub> in Beijing with Multiple Models” by Y. Liu et al.***

### **Anonymous Referee #3**

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In this study, the authors implemented a combination of PMF, footprint, and NAQPMS models to identify the sources and regions of PM<sub>2.5</sub> in Beijing. The PMF model was used to find out the sources of PM<sub>2.5</sub>. To this end, the chemical components of PM<sub>2.5</sub> were used as the input to the PMF model. Then the PMF results were combined with footprint and NAQPMS models to identify the evolution of different episodes. Overall, the paper is well written in English and the results are promising. However there are some comments which need to be addressed in order to make it a good candidate for publication in ACP. I believe that the paper can be accepted after addressing these comments:

Line 52- please add two or three more references for the PM<sub>2.5</sub> source apportionment studies. For example you might add the following papers:

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Kotchenruther, R. a., 2016. Source apportionment of PM<sub>2.5</sub> at multiple Northwest U.S. sites: Assessing regional winter wood smoke impacts from residential wood combustion. *Atmos. Environ.* 142, 210–219.

Taghvaei, S., Sowlat, M.H., Mousavi, A., Hassanvand, M.S., Masud, Y., Naddafi, K., Sioutas, C., 2018. Source apportionment of ambient PM 2.5 in two locations in central Tehran using the Positive Matrix Factorization ( PMF ) model. *Sci. Total Environ.* 629,

Zong, Z., Wang, X., Tian, C., Chen, Y., Qu, L., Ji, L., Zhi, G., Li, J., Zhang, G., 2016. Source apportionment of PM<sub>2.5</sub> at a regional background site in North China using PMF linked with radiocarbon analysis: Insight into the contribution of biomass burning. *Atmos. Chem. Phys.* 16, 11249–11265.

Line 106- I suggest you to add references for your claim that "the sampling site is representative of the Beijing urban area" (if applicable).

Line 111- You need to mention more details regarding the usage of Semi-continuous OC/EC Carbon Aerosol Analyzer (Sunset Laboratory Inc.) (e.g., thermal protocols used). Please also add references for the instrument.

Line 142- You definitely need to present the average concentration of PM<sub>2.5</sub> chemical components in a table for different episodes of your study. This table should also include the min, max, signal/ noise (S/N) ratio for your data as the important parameters in PMF analysis.

Line 149- please add the (Norris et al., 2014; Paatero and Tapper, 1994; Paatero et al., 2014; Paatero, 1997) as the main references for PMF model:

Paatero, P., 1997. Least Squares Formulation of Robust Non-negative Factor Analysis. pp. 23–35.

Paatero, P., Tapper, U., 1994. Positive matrix factorization: a non-negative factor model with optimal utilization of error estimates of data values. *Environmetrics* 5, 111–126.

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Paatero, P., Eberly, S., Brown, S.G., Norris, G.a., 2014. Methods for estimating uncertainty in factor analytic solutions. *Atmos.Meas. Tech.* 7:781–797. <https://doi.org/10.5194/amt-7-781-2014>.

Norris, G., Duvall, R., Brown, S., Bai, S., 2014. EPA Positive Matrix Factorization (PMF) 5.0 Fundamentals and User Guide.

Line 163- Please provide the Q robust values for different PMF solutions in an SI figure. This would be really helpful in showing why you picked the 6 factor solution as the optimal PMF resolved solution.

Line 166- In addition to briefly touching the results of your uncertainty analysis, you need to mention the uncertainty analysis results in detail (more discussions can be found in PMF source apportionment papers)

—Why the simulation period for footprint model, and NAQPMS model are not the same? For example, the footprint simulation was performed from 1-31 December while the NAQPMS model analysis was performed from 10th of November to 15th of December.

Line 247- Please add a couple of references for the following sentence:

In general, the large contribution of SIA, OM as well as the high OC/EC ratio indicated the importance of secondary formation in winter in Beijing, while the high concentration of species like SO<sub>4</sub><sup>2-</sup> and K suggested a significant contribution of combustion sources to PM<sub>2.5</sub>.

Line 255- As a general comment, you need to add references while mentioning different chemical components as tracers of a specific source. For example, references are required for the fact that K is a tracer of biomass burning.

Line 260-275: Unfortunately, the source apportionment profiles are not distinguished well. For example, K as a tracer of biomass burning has higher percentage of contribution in Industrial sources rather than the biomass burning. In addition, we have sig-

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nificant loadings of Na<sup>+</sup> and Ni (which are not tracers of biomass burning) in biomass burning profile. How do you justify your source profiles?

Line 335- How do you compensate the lack of data for regional and local contribution from the NAQPMS model for the EP4?

Line 425- Authors should include the limitations of their research. Please add the limitations as a separate session.

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Interactive comment on *Atmos. Chem. Phys. Discuss.*, <https://doi.org/10.5194/acp-2018-1234>, 2018.

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