

## ***Interactive comment on “Contributions of Trans-boundary Transport to the Summertime Air Quality in Beijing, China” by Jiarui Wu et al.***

### **Anonymous Referee #1**

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The authors employed the WRF-CHEM model to assess the contributions of trans-boundary transport to air quality in Beijing during a persistent air pollution episode from 5 to 14 July 2015 in Beijing-Tianjin-Hebei (BTH), China. They showed that the WRF-CHEM model reproduced well the temporal variations of the aerosol species compared to the measurements in Beijing. The authors indicated a large contribution from the regional transport and suggested that a coordinated mitigation for pollutant emissions with neighboring provinces is key to improve air quality in Beijing. This is a good work to investigate the air pollution problem in China and, in particular, provides quantitative insight into the contributions of trans-boundary transport of outside emissions the PM<sub>2.5</sub> and O<sub>3</sub> levels in Beijing. The paper was in general reasonably well written, although it could be benefitted from additional editing. I recommend publication of this work, after a revision to address the following issues.

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Their last statement in the abstract sounded to be out-placed and non-substantiated. It has been commonly well established that the accuracy of simulations by chemical transport models (such as WRF-CHEM) is largely dependent of several factors, including emission inventory, chemistry, and meteorological fields (including the PBL height) (e.g., Zhang et al., Formation of urban fine particulate matter, Chem. Rev. 115, 3803, 2015). What was really missing from this manuscript is a careful account of those various factors that impact their simulations and conclusions.

For example, the different VOC types exhibit distinct kinetic behaviors, and their contributions to O<sub>3</sub> and SOA formation are also distinct (e.g., Suh et al., Oxidation mechanism of aromatic peroxy and bicyclic radicals from OH-toluene reactions, J. Am. Chem. Soc. 125, 12655, 2003; Fan et al., Atmospheric oxidation mechanism of isoprene, Environ. Chem. 1, 140, 2004). How well was the VOC EI represented in the model, and how did the VOC EI uncertainty impact their simulations?

The PM problem in Beijing has been well characterized by efficient and rapid secondary formation (Guo et al., Elucidating severe urban haze formation in China, Proc. Natl. Acad. Sci. USA 111, 17373, 2014; Zhang et al., Insufficient evidence for the contribution of regional transport to severe haze formation in Beijing, Proc. Natl. Acad. Sci. USA 112, E2741, doi:10.1073/pnas.1503855112, 2015). How well did their model handle those secondary PM formation processes, including nucleation and growth from the various organic and inorganic species (Fan et al., Contribution of secondary condensable organics to new particle formation: A case study in Houston, Texas, Geophys. Res. Lett. 33, L15802, doi:10.1029/2006GL026295, 2006). How well did their model handle the particle-phase reactions, including those associated with small di-carbonyls (glyoxal and methyl glyoxal) that could be particularly important for urban PM formation because of their traffic origin (Zhao et al., Heterogeneous reactions of methylglyoxal in acidic media: Implications for secondary organic aerosol formation, Environ. Sci. Technol. 40, 7682, 2006; Gomez et al., Heterogeneous chemistry of glyoxal on acidic solutions – An oligomerization pathway for secondary organic aerosol formation, J.

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Phys. Chem. 118, 4457, 2015).

Another problematic area was related to the MET part, including PBL. In particular, it has become clear that the PBL-pollution interaction plays a key role in pollutant accumulation in Beijing (Wang et al., Light absorbing aerosols and their atmospheric impacts, *Atmos. Environ.* 81, 713, 2013; Peng et al., Markedly enhanced absorption and direct radiative forcing of black carbon under polluted urban environments, *Proc. Natl. Acad. Sci. USA* 113, 4266, 2016).

The manuscript contained some stylistic/grammatical/typographic errors, which hindered its readability. Here are a few examples. In the title, delete "the". Line 19, replace "emissions outside of Beijing" by "outside emissions" Line 23 and other places, the word "pure" is ambiguous and can be deleted or replaced by "the local-only emissions". Line 21-22, "pure emissions outside of Beijing" to "the outside emissions". Line 23, "local emissions with those outside of Beijing" to "local and outside emissions". Line 23, "The pure emissions outside of Beijing" to "The outside emissions". Line 25, "pure Beijing local emissions" to "the local emissions". Line 25, "The emissions interactions" to "The interactions between local and outside emissions". Line 31, "need to be performed to improve" to "are needed to improve".

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