

Reply to Anonymous Referee #1

We thank the reviewer for the careful reading of the manuscript and helpful comments. We have revised the manuscript following the suggestion, as described below.

This manuscript presents an investigation of the impacts of trans-boundary transport of air pollutants originated from the North China Plain on regional air quality in the Northeast and Northwest China. Contributions of air pollutants from neighboring regions to local air quality become significant especially under prevailing meteorological conditions such as Asian Summer Monsoon seasons (ASM). However, it is quite difficult to assess to what extents the impacts of the trans-boundary transport are and to date few studies are available in the literature, hindering the effective measures from proposing regarding pollution control and prevention. The paper is well written and organized and only a few minor issues need to be resolved before its final publication in the journal.

1 Comment: When quantitatively assessing the impacts of the trans-boundary pollutants from NCP on the NEC or NWC regions, it is necessary to estimate the uncertainties and include them in the evaluation. In addition, a clear list of all possible sources of uncertainties is needed in the assessment.

Response: We have included the uncertainties (standard deviation) in Table 2 and Table 3 and also clarified in Section 3.3.2: *“Furthermore, it is worth noting that uncertainties from meteorological field simulations, emission inventories, and the chemical mechanism used in simulations, have large potentials to influence evaluation of the effect of the NCP emissions on the PM_{2.5} and O₃ concentrations in the NEC and NWC (Carter and Atkinson, 1996; Lei et al., 2004; Song et al., 2009; Bei et al., 2017).”*

2 Comment: The validation of separating different contributions (e.g., local, transport etc.) seems to be lack of clear support. Why other processes for example secondary reactions of air pollutants are not included in the method of separation?

Response: We have clarified in Supplement Information (SI) Section 2.1: *“The formation of the secondary atmospheric pollutant, such as O₃, secondary organic aerosol, and nitrate, is a complicated nonlinear process in which its precursors from various emission sources and*

transport react chemically or reach equilibrium thermodynamically. Nevertheless, it is not straightforward to evaluate the contributions from different factors in a nonlinear process. The factor separation approach (FSA) proposed by Stein and Alpert (1993) can be used to isolate the effect of one single factor from a nonlinear process and has been widely used to evaluate source effects (Gabusi et al., 2008; Weinroth et al., 2008; Carnevale et al., 2010; Li et al., 2014a)." The detailed description of factor separation approach can be found in Supplement Information (SI) Section 2.1.

3 Comment: Why PM_{10} is not included in quantitative evaluations? Is it because not significant in term of concentration or there are other reasons?

Response: We have clarified in Section 3.3: *"In the present study, the effect of the NCP emissions on the $PM_{2.5}$ and O_3 concentrations in the NEC and NWC is evaluated, considering that they have the long lifetime of several days in the troposphere and often constitute the primary air pollutant during summertime (Seinfeld and Pandis, 2006). However, the trans-boundary transport of PM_{10} is not considered due to its short lifetime of several hours caused by the dry deposition and gravity and the fact that PM_{10} is generally confined to its source region when the wind is not strong enough (Sun et al., 2006)."*

A few other rather minor points:

1) L32 on p1, however might be better to be moved to the beginning of the sentence.

Response: We have moved "however" to the beginning of the sentence in abstract.

2) L52 on p2, pollutants emissions? Emissions of pollutants might be better. There are quite a few on other pages.

Response: We have revised "pollutants emissions" as "emissions of pollutants" in Section 1.

3) L73 on p3, tend should be tends.

Response: We have revised "tend" as "tends" in Section 1.

4) L114 on p4 and other pages, “The further description”, here “The” is not needed.

Response: We have deleted “The” in Section 2.1.

5) L152 on p6, it is “Results and Discussion”.

Response: We have revised “Results and Discussions” as “Results and Discussion” in Section 3.

6) L190-191 on p8, the values of 0.69 and 0.62 are not significant different, similar for the values of 0.87 and 0.84.

Response: We have clarified in Section 3.1: “*The decreasing trend of the correlation coefficients also exists from east to west in the NWC, with coefficients of 0.69 and 0.62 for $PM_{2.5}$, and 0.87 and 0.84 for O_3 in Shanxi and Shaanxi, respectively.*”.

7) There are a few acronyms (i.e., IOA, MB) that needed to be specified.

Response: We have clarified in Section 2.2: “*The mean bias (MB), root mean square error (RMSE) and the index of agreement (IOA) are utilized to evaluate the performance of the WRF-CHEM model simulations against measurements.*” The detailed description about the statistical methods can be found in Supplementary Information (SI).

8) Why 8:00 and 14:00 are respectively used in Figures 7 and 8? Why not other times?

Response: We have clarified in Section 3.2.3: “*The peak $PM_{2.5}$ concentration generally occurs from 08:00 to 10:00 Beijing Time (BJT) during the simulated episode.*” and “*The O_3 concentration during summertime generally reaches its peak from 14:00 to 16:00 BJT in Northern China (Figure 5).*”.

9) L266 on p11, you cannot use something like “the most remarkable”.

Response: We have revised “the most remarkable” as “remarkable” in Section 3.3.1.

10) L288 on p11, in most areas not in the most areas.

Response: We have revised “in the most areas” as “in most areas” in Section 3.3.1.

ning, Shanxi, Shaanxi and Inner Mongolia, respectively.”.