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.

WRF-Chem simulations with perturbed emissions are performed to quantify the contribution of residential coal combustion (RCC) to the particulate pollution in Beijing and surrounding region. The model shows good agreement with surface measurements on $PM_{2.5}$ and speciated aerosol mass concentrations, which makes the following sensitivity simulations more reliable. The comparison of the RCC from Beijing versus the surrounding region provides a quantitative assessment of the efficiency of the residential coal replacement plans for the policy makers. The paper can be accepted by ACP after my following questions can be addressed.

1 Comment: The description of all the sensitivity experiments should be summarized in the Model and Methodology. More details should be provided what species in the emission inventories are turned off in each sensitivity run.

Response: We have clarified the sensitivity simulations in Section 2.1 "*In the present study, we have conducted one reference simulation in which emissions from various anthropogenic and biogenic sources are considered (hereafter referred as to the REF case). The results from the REF case are compared with observations in BTH to validate the model performance. Additional two sensitivity simulations have also been performed, without the RCC emission in BTH and its surrounding areas and Beijing, respectively (hereafter referred as to the SEN-BTH case and SEN-PEK case). In the sensitivity simulation, the emission of NO_x, CO, VOCs, SO_2, black and organic carbon, primary sulfate, and unspecified particulate matters from the RCC is turned off. The difference between the reference and sensitivity simulation is used to evaluate contributions of RCC emissions to the air quality in BTH and Beijing.*".

2 Comment: Total OA simulation is reported to be consistent with observations. Meanwhile, the authors mentioned the POA and SOA observations are available during the simulation time. It is interesting to know how OOA (representing SOA) is simulated in the model? In other words, is the primary/secondary ratio right for the aerosol sources

in the model?

Response: We have clarified in Section 3.1.2 "*The modeled $PM_{2.5}$ mass concentration averaged during the simulation period in BTH and Beijing is 111.6 and 97.7 μg m^{-3}, respectively. OA dominate the $PM_{2.5}$ in BTH, with a contribution of around 43.1%. Although the simulated O_3 concentration is low, the secondary aerosols, including SOA, sulfate, nitrate, and ammonium still make up about 40% of the $PM_{2.5}$ mass concentration, with contributions of 7.9%, 11.3%, 12.4%, and 9.6%, respectively. Elemental carbon and the unspecified aerosol species account for 7.5% and 16.2% of the $PM_{2.5}$ mass concentration, respectively. In Beijing, sulfate, nitrate, and ammonium constitutes 10.6%, 14.0%, and 9.1% of the $PM_{2.5}$ mass concentrations, respectively. OA are also the dominant constituent of the simulated $PM_{2.5}$ in Beijing, with a contribution of about 44.1%. The simulated ratio of the primary to secondary ratio OA in Beijing is 4.6, which is close to the observed ratio of 4.3.*"

3 Comment: L279, was the electricity mainly from coal burning as well? L281, why the coal replacement plan in Beijing is controversial?

Response: We have clarified in Section 3.3 "*It is worthy to note that the electricity is principally from the coal burning in China, and the main air pollutants emitted from coal-burning power plants are NO_x and SO_2. However, the major pollutants emitted by the residential coal combustion include organic carbon, SO_2 and NO_x. Considering the dominant role of OA in the $PM_{2.5}$ in Beijing, the coal replacement in residential living is more effective in power plants.*".

4 Comment: L333, "bring back the blue sky to Beijing" is a vague statement. What's the definition of "blue sky"? Better to use some criteria in term of PM level.

Response: We have modified the expression in Section 4 "*Hence, the coal replacement plan in Beijing is beneficial to the local air quality, but is not as anticipated to substantially improve the air quality.*".

5 Comment: L340, the conclusion here is somewhat objective. 18% reduction can be considered "significant" as well. Please rephrase the sentence.

Response: We have rephrased the sentence in Section 4 "*Our results indicate that if the residential coal replacement is only implemented in Beijing, Beijing's air quality will be improved considerably, but not substantially, considering the impact of trans-boundary transport.*".

6 Comment: Is the atmospheric stability or air stagnancy changed by the coal emission as well? Light absorbing aerosols are thought to alter the ambient temperature profile locally [Wang et al., 2013; Zhang et al., 2015; Peng et al., 2016]. Your WRF-Chem simulations with aerosol-meteorology interactions should be able to answer such questions. A related question is what is the TOA radiative forcing from RCC in your simulations?

Response: We have clarified in Section 3.2 "*It is worth noting that light absorbing aerosols are thought to alter the ambient temperature profile locally (Wang et al., 2013; Zhang et al., 2015; Peng et al., 2016). The sensitivity results indicate that if the RCC emission in BTH and its surrounding areas is excluded, the surface temperature in BTH is decreased by about 0.23℃ on average during the study period, about half of which is contributed by light absorbing aerosols.*".

7 Comment: Are the modeled CO spatiotemporal variations well correlated with total $PM_{2.5}$ or a part of it like EC? Recently more observational studies use CO as an aerosol proxy to conduct aerosol related researches using the remote sensing technique.

Response: The modeled CO spatiotemporal variations is well correlated with the $PM_{2.5}$ and we have further correlated CO with $PM_{2.5}$ mass concentrations in Section 3.1.1 and Figure 5: "*Recently, observational studies have used CO as an aerosol proxy to investigate atmospheric aerosols based on the remote sensing technique. Figure 5 shows the scatter plots of observed and simulated $PM_{2.5}$ with CO mass concentrations averaged over all ambient monitoring sites in BTH during the simulation period. The observed and simulated CO mass concentrations are well correlated with those of $PM_{2.5}$, with the R^2 exceeding 0.81.*".

8 Comment: Questions on the figures:

• Figure 2, please thicken the circles in the plot, as they are hardly to see.

Response: We have modified Figure 2 (now Figure 3) as suggested.

• Figure 4, are they averaged over the 17 days from 9 to 25 January? If yes, I would expect to see a smoother diurnal variation in those plots. The spikes of OA and CCOA near 1800 look very sharp.

Response: Figure 4 (Now Figure 6) shows the diurnal variations of the observed and simulated aerosol species from 9 to 25 January. The spikes of OA and CCOA are caused by the irregular residential emissions near the observation site.

• Figure 8, please specify what each color stands for in the figure caption.

Response: We have clarified in the caption of Figure 8 (Now Figure 10): "*The green, yellow, orange, red, purple, and dark red represents excellent, good, slightly polluted, moderately polluted, heavily polluted, and severely polluted levels of air quality, respectively.*".

9 Comment: Some grammar and English writing issues:

• L16, L316 assess contributions.

• L149, pollution simulations.

• L176, replicates.

• L184, reasonably yields.

• L272, from southwest to northeast. The usage of article is problematic in several places, please pay more attention.

• L292, still debatable.

Response: We have revised the manuscript as suggested.