Reply to Anonymous Referee #2

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.

The authors present a WRF-CHEM modeling study on quantifying the impacts of residential coal combustion (RCC) emissions on air quality in the BTH region. This study is done under the background that the BTH region has been plagued with persistent heavy haze pollution, coal combustion is a major pollutant emission source in this region, and there has been a debate on the roles of local emissions and regional transport in the haze pollution in Beijing. They conclude that although local RCC emissions make an important contribution to the haze pollution in Beijing, it is necessary to control the RCC emissions in the entire BTH and its surrounding areas in order to significantly reduce the haze levels in Beijing. The manuscript is well organized and presented, and the methodology is sound. It can be published with minor revisions.

1 Comment: According to the information in the Introduction (L81-91), there have been several model studies regarding the impacts of the emissions of coal combustion and/or RCC on air quality in the BTH. What are new in this study compared to these studies? Are the results of this study consistent with other studies, and if not, why?

Response: We have clarified in Section 1: "*Control strategies have also been implemented to reduce residential emissions, but evaluation means constrained by observations are still lacking.*" and "*Until now, there have been few studies focusing specially on the impacts of RCC emissions on the air quality in BTH.*". The results of this study are not consistent with those of other studies which generally evaluate the contribution of residential living emissions to the air quality in China.

2 Comment: When discussing the modeling discrepancy, the authors emphasize the bias from simulated meteorology. Emissions as another likely factor should also be addressed. The effect of the meteorology uncertainty should affect all pollutants, especially primary pollutants, not just $PM_{2.5}$. As such, the authors should also examine if the earlier fall-off and underestimation occur to other pollutants (especially primary

pollutants, such as CO and SO_2); if it does, it provides additional evidence for the factor of meteorology; if not, other factors need to be taken into account.

Response: We have clarified the impact of uncertainties in emission inventory and meteorology to the modeling biases in Section 3.1.1 "*The early occurrence of intensified winds in simulations also cause rapid falloff of SO_2 and CO mass concentrations during the haze dissipation stage. Besides uncertainties in meteorological field simulations, uncertainties in emission inventory are also responsible for the model biases of air pollutants. Since implementation of the APPCAP, strict emission control measures have been made to improve the air quality in BTH, and the spatiotemporal variations of anthropogenic emissions in BTH have changed considerably (Li et al., 2017), which is not reflected in the emission inventory used in the present study.*".

3 Comment: L225, it would be helpful to provide the numbers by Huang et al (2014).

Response: We have clarified in Section 3.1.2 "*The simulated chemical composition in Beijing is generally comparable to the observation in January 2013 by Huang et al. (2014), showing that OA constitutes a major fraction (40.7%) of the total $PM_{2.5}$, followed by sulfate (16.0%), nitrate (12.0%), and ammonium (9.8%). It is worth noting that the simulated sulfate contribution to $PM_{2.5}$ mass concentrations in Beijing is lower than the observation in Huang et al. (2014), and vice versa for the nitrate aerosol. Implementation of the APPCAP since 2013 September has considerably decreased SO_2 emissions in BTH, lowering the sulfate formation. Additionally, the decrease of the sulfate aerosol reduces its competition with ammonia in the atmosphere, facilitating the nitrate formation.*".

4 Comment: L268, I suggest to change the section title to something like "Contribution of local RCC emissions to air quality in Beijing" to differentiate section 3.3 and the case of "SEN-BTH".

Response: We have changed the section title of 3.3 to "*Contributions of local RCC emission to the air quality in Beijing*".

5 Comment:

• L280-282, deliberate the “controversial issue”.

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 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.*”.

• L309, 25% contribution by local RCC does not warrant the RCC to be the MAIN cause.

Response: We have clarified in Section 3.3 “*Apparently, the mitigation effect is the best under good and lightly polluted conditions in terms of $PM_{2.5}$ level, and the $PM_{2.5}$ mass concentration decreases by around 25% when the RCC emission in Beijing is not considered, indicating that the local RCC emission does not constitute the main $PM_{2.5}$ pollution source in Beijing.*”.

• L311 -312 and L336-337, you use the number of RCC contributing 15-20% to $PM_{2.5}$ during moderate to severe pollution conditions to argue the importance of regional transport to the haze pollution in Beijing. There is a flaw in the argument, since there might be local anthropogenic emissions other than RCC that could make significant contributions too. To argue the importance of the regional transport, you better to contrast the results in the cases of BTH-SEN and SEN-PEK (30% vs 18%, i.e., 12% from the RCC emission transport vs 18% from local RCC) to conclude.

Response: We have clarified in Section 3.3 “*Sensitivity studies show that when only the RCC emission in Beijing is excluded in simulations, the $PM_{2.5}$ level is decreased by 18%, much less than about 30% decrease caused by the exclusion of the RCC emission in BTH and its surrounding areas, showing the important contribution of trans-boundary transport to the air quality in Beijing.*”.

6 Comment: The language needs to be polished. Following are some examples:

• The use of “vice versa” in L206 and L225 is not correct. You mean “opposite”?

Response: We have changed “vice versa” to opposite as suggested.

• The use of “dispersion” in L186 and L199 is not appropriate either; you mean bias or disparity? Delete “well” in L154, 173, 176, 184, 192 and 343;

Response: We have changed “dispersion” to “deviation” in Section 3.1.1. We have deleted “well” as suggested.

• In L21, 174, 177, L193, and L318, change “compared with” or “compared to” to “when compared with” or “against”.

Response: We have changed “compared with” to “compared to” or “against” as suggested.

7 Comment: Delete the first name initials in L81-88

Response: We have deleted the first name initials as suggested.