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Interactive comment on "Attributions of meteorological and emission factors to the 2015 winter severe haze pollution episodes in Northern China" *by* Tingting Liu et al.

Anonymous Referee #1

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General comments:

This work aims at attributing impacts of meteorology and emissions to the formation of severe air pollution episodes in northern China between 2014 and 2015, the latter of which seeing worsened wintertime pollution regardless of improved air quality in earlier months. The manuscript is well organized and clearly presented. While it is well known that both emission and meteorology control the level of air pollution, quantitative analysis has rarely been conducted. This work presents employs ground observations and atmospheric modeling to differentiate the contribution by each factor, providing scientific insight to similar phenomena elsewhere. There are a few issues concerning the analytical approach used here and the conclusions drawn from these analyses that

need to be adequately addressed before it can be considered for publication at ACP.

Major comments:

1. The approach for meteorological factor analysis: It is an interesting approach to examine the linkage between weather pattern and PM2.5 level. It seems that some meteorological parameters are more strongly associated with PM2.5 concentrations than others. The analysis can be enhanced if these associations can be illustrated by comparing the correlations between PM2.5 and each parameter (wind speed, wind direction, temperature, and relative humidity) in the two years.

2. Considerable uncertainty may be associated with the indirect method utilized to quantify emission contribution to wintertime PM2.5 changes between the two years. The emission contribution is derived from the difference between simulated and observed PM2.5 changes under the meteorological conditions representing 2014 and 2015. The model simulations are subject to uncertainty in predicting both meteorological parameters and PM2.5 concentration (e.g., Table 1). It may be useful to address these uncertainties by first evaluating the model skills to predict key meteorological parameters.

3. A more direct method to quantify emission contribution would be to conduct additional simulations by using emission data representing the two winters. A challenge of such a method is to obtain accurate emission trends for key precursors to PM2.5. It may be possible to derive such trends from the ground or satellite observations near emission sources or during particular time window (e.g., 6-9am local time for mobile sources from near road monitors). Adding these additional analyses will make the emission attribution more convincing.

Specific comments:

Page 2: L2-3 with an annual mean concentration of fine particulate matter (PM2.5) ranging from . . .

L6: change “negative” to “adverse”.

L12: change drop to dropping;

L18: change “hardly combined” to “did not consider”;

Page 3: L11-12: study of air pollution conditions in the last two months of 2015

L15: give abbreviations for both terms first used here.

Page 6: Figure 2. It is difficult to discern the numbers and text in these maps. Please simplify the background and highlight the text/numbers relevant to the main message here.

Page 7: Table 1. If we use SO2 as an indicator to coal burning emission sources and NOx to mobile sources, it seems that either coal burning was significantly lower in 2015, or SO2 to sulfate conversion was more efficient, regardless of increased concentrations in CO and NO2 from 2014 to 2015. How important is sulfate to PM2.5 in these cities? If chemical speciated measurements of PM2.5 are available during this study, it would interesting to analyze the SO2 to sulfate ratio and NO2 to nitrate ratio to see if the gas-to-particle conversion has changed over time. It will be useful to understand the relative contribution from emissions, transport, or gas-to-particle processes.

Page 8: L2. How was WSCL calculated here? Please provide either details of the calculation or a traceable reference.

Page 9: L1. Please clarify “temperature anomaly”. Is it higher or lower than the average?

L4. northward?

L14. Remove “were”.

Page 10: L9: 2015

Page 11: L2: remote “was” L13: more than 27% or doubled?

Page 13: L9: emission modeling system; L14: mode(l)

P15: L1: define how was the difference percentage calculated.

P16: L1-3: the 8% seems be reasonable for emission changes from one year to the next, but the number is very small considering the large changes and opposite directionality in PM2.5 precursor concentrations.

Table 3: large discrepancy exists between observed and simulated PM2.5 concentrations. What are the major reasons underlying these biases and how will the biases be propagated into the met/emission attribution?

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