Replies to the comments

1. Line 21 “PM2.5 concentration and visibility in Zhongshan”, averaging all the grids in Zhongshan or averaging all the grids where observation sites are in Zhongshan? How many observation sites in Zhongshan?

Answer: Thank you for the question. In fact, now there are 4 sites in Zhongshan for air quality observation. But those 4 sites are not far away from each other and the observational and simulated data do not vary a lot among these 4 sites. So we average the girds where observation sites located for the model evaluation. Lines 195 to 199 in section3.2 are rewritten for this question.

2. Lines 86 to 89 “Simulation tests adopted ------ Province”, what is the boundary condition used in the simulation domain 1?

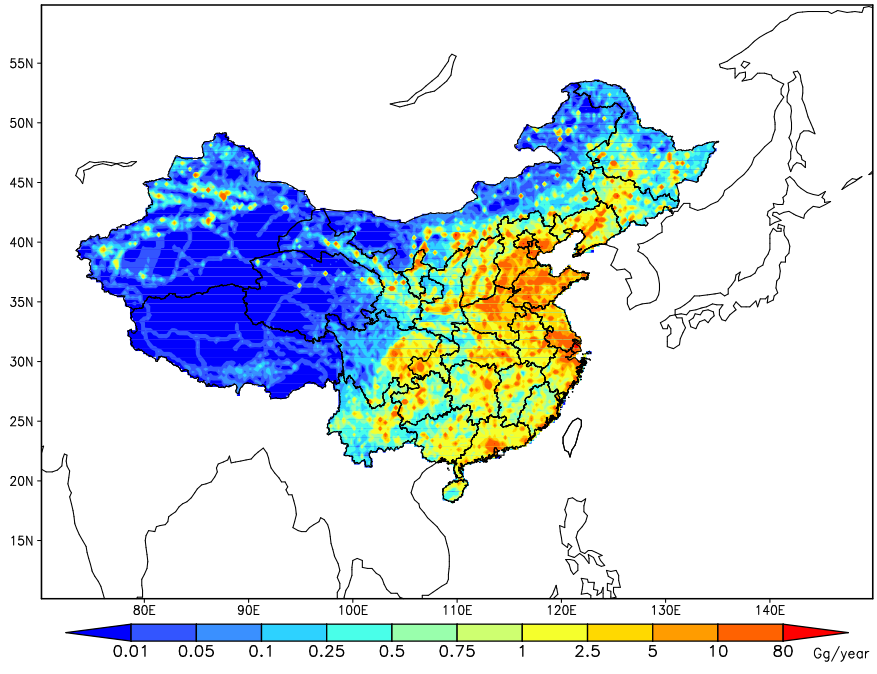
Answer: Good question. We used the default boundary condition of the CMAQ model in domain 1. Certainly that would lead to some simulation uncertainty. But the area of domain 1 which covers the entire east Asia is already big enough and we mainly focused on the Guangdong Province. So we believed that the uncertainty from the boundary condition in domain 1 would not have much influence to the simulation of domain 2. Lines 83 to 84 in section2.1 are rewritten for this question.

3. Lines 117 to 119 “The emission source data ------was 0.25° x 0.25°”. 0.25° is about 28km. The resolution of simulated domain 2 in 9km. Using a coarse resolution emission in a finer resolution model grid is not encouraged. Can the author describe how he did this emission conversion?

Answer: That is an important question. The emission source data from Tsinghua University which we used in our research is the best one in China currently. Since the resolution of the data was 0.25° x 0.25°, the emission data was deal with a spatial interpolation method to fit the simulation and this is proved to be effective in our tests. Also the temporal variations of the dataset are set following the work of Zheng. Lines 115 to 117 in section2.1 are rewritten for this question.

4. Line 132, Figure 2b, Annual NO emission. It seems that NO area sources are dominant. No mobile signals are clearly observed from the plot, for example line emissions along the high way. Why?

Answer: Thank you for the question. We believe that the mobile signals are not clear in the plot because the highways are just too dense in Guangdong Province. Besides, area sources also give a great amount emission of NO. Below is a plot of NO emission in China and we can see clear mobile signal in the plot, especially in the western China.



5. Lines 172 to 173 "The observational data ------ (113.35° E, 22.53° N)" only one site observation used in meteorological evaluation is far from enough.

Answer: Thank you for the advice. Now we add Guangzhou (113.33° E, 23.17° N) at the north of Zhongshan and Zhuhai (113.57° E, 22.28° N) at the south of Zhongshan for meteorological evaluation. The location of the sites can be found in Figure 1. And because the wind direction data are incomplete, so the evaluation of wind direction is deleted. Section 3.1(lines 172 to 192) is rewritten for this question.

6. Lines 177 to 180 "Figure 3 ------ the observational data" hourly data is more convincing that daily average data and please define what is 24-hour pressure variation.

Answer: Thank you for the advice. Meteorological elements such as temperature change regularly in a day (e.g., high temperature in the day and low temperature in the night). If using hourly data, the temperature variation from day to day may not be easily found out in consecutive days. That was why we used daily average data instead of

hourly data. 24-hour pressure variation is a useful parameter when we talk about the movement of cold front in China. It is the variation of pressure at a certain time of a day and a day before (e.g., the variation of pressure between 8:00 today and 8:00 yesterday). If the 24-hour pressure variation is positive in winter, possibly we are affecting by a cold front. Lines 178 to 180 in section3.1 are rewritten for this question.

7. Line 205 "Evaluation of CMAQ model results", please describe the observation data that is used in CMAQ evaluation.

Answer: Thank you for the advice. Observation data used in CMAQ evaluation is from Zhongshan Protection Bureau and we only adopted the hourly data. Currently there are four observation sites in Zhongshan, which are not far from each other (also mention in question 1). So we averaged the data from those four sites for model evaluation. Also we averaged the model output of grids where the observation sites located in Section 3.2. Lines 195to 199 in section3.2 are rewritten for this question.

8. Line 217 "the weak simulation of cold front", please define clearly what the weak cold front is and provide the criteria of the author categorized the weather pattern into no cold front, weak cold front and strong cold front.

Answer: Thank you for the advice. In question 6 we define 24-hour pressure variation, a parameter relate to the movement of cold front. Here we further provide the criteria of cold front. In our paper, if the 24-hour pressure variation is negative, we define it a no cold front case; if the 24-hour pressure variation is between 0hPa and 3hPa, that is a weak cold front case; if the 24-hour pressure variation is more than 3hPa, we categorize it a strong cold front case. So "the weak simulation of cold front" refer to the simulated 24-hour pressure variation was weaker than the observation. Lines 209 to 210 in section3.2, lines 284 to 295 in section4.1 are rewritten for this question.

9. Line 312 Figure 6, what does others mean? Please describe clearly in the text.

Answer: Thank you for the question. We divided the emission source into four parts: the source of local Zhongshan, the source of other cities in PRD, source outside Guangdong Province, and the other source outside PRD in Guangdong, which have little contribution to Zhongshan. Lines 136 to 139 in section2.2, lines 301 to 302 in section4.1 are rewritten for this question.

10.Line 388 Table 5, since there is no PM25 speciation evaluation, the results shown in Table 5 may not be that convincing.

Answer: Thank you for the advice. Currently there is almost no observation for PM25 speciation in Zhongshan. We agree that the results shown in Table 5 may not be that convincing. After a discussion of our team, we decided to delete Section 4.2, a less important part in our paper.

11. Line 438 Table 7, Are they all based on Zhongshan emission turning off case?

Answer: Thank you for the question. Results shown in Table 7 are all based on Zhongshan emission turning off case and our purpose was to evaluate the contribution ratio of industrial, residential and transportation sources to local Zhongshan separately. Lines 379 to 381 in section4.2 are rewritten for this question.