Response to reviewer

We are very thankful to reviewer for his/her constructive criticisms and valuable comments, which were of great help in improving the quality of the manuscript. We have revised the manuscript accordingly and our detailed responses are shown below.

Referee 2

1. p2 line 39: The authors mention "The real-time traffic data from the road network could be the most precise input data for on-road emission inventories and could significantly improve the spatial and temporal resolution of the inventories."

I believe this is the central point of the work presented. The targeted question is to know if "real" traffic data can help to improve the quality of modelled emissions and then the quality of modelled concentrations.

Of course the first step is to be able to use such data. The work presented shows it is technically possible. The second step is to show that it allows to get reasonable emissions and then reasonable concentrations. The manuscript provides some elements for this second step.

However what is missing in this work, from my point of view, is the demonstration of the interest of the proposed methodology in comparison to previously existing methods. It could have been relevant to compare a simulation with the emissions derived from the new methodology to a simulation with emissions derived from time-averaged data and applying hourly, daily and monthly factors as often applied within Top-Down approaches. Similarly the comparison to spatially-averaged data (at a chosen grid cell scale and per type of ways) would be of interest.

Reply:

Thank you for your helpful suggestion. We had known that this is important to compare our results with other existing emission inventories as many details as we can, no matter those inventories were establish by top-down or bottom-up method. However, due to the lack of data of the other inventories, some comparisons are unable to achieve in this study. Even so, we had tried out best to add more details about the comparison between our results and others. In section 4.1.2, we had compared the spatial distribution with other two inventories. In page 7, line 26-32, "*Moreover, the spatial distributions of these three emission inventories were compared in this study. Figure 10 shows the distribution of CO from the three different inventories. In urban areas, the results of both MEIC-2016 and PRD-2015 showed the urban areas as emission hotspots. However, the results from the ROE model were much lower for such areas. This may be due to the fact that the ROE model considers the traffic control policies, while the other two inventories do not. In suburban town centers, especially in the eastern and southern parts of Guangzhou, all three inventories showed the same results, namely that these areas were large contributors of on-road emissions. Notably, highways and arterial roads also contributed high emissions in all three inventories.*"

"*However, it should be noted that this comparison was only preliminary; the spatial resolutions of three inventories are inconsistent. Moreover, due to the lack of temporal information in the other* *two emission inventories, a comparison of the temporals difference could not be conducted. Future studies should focus on improving the accuracy of such comparisons.*" (In page 9, line 37-40)

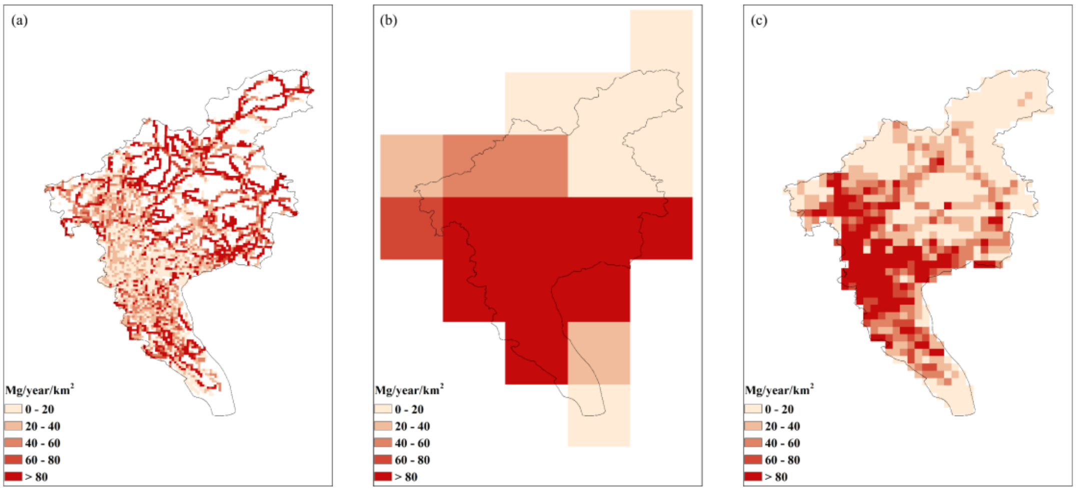

Figure 1. Spatial distribution of CO from (a) ROE model, (b) MEIC-2016 and (c) PRD-2015 in Guangzhou.

2. p3 line 4: Strictly speaking it is not the case for all air pollutants. This sentence could be rewritten avoiding this useless generalisation.

Reply:

Thanks for pointing out this. We had revised the sentence by "*Many studies have successfully applied the regional-scale CTMs to investigate the impact of on-road vehicles on the air quality in urban areas in the regional scale (~100 km).*" in page 3, line 4-5.

3. p3 line 26: This sentence should be rewritten to clarify what is available currently (it is always possible to develop a model to extend its functionalities).

Reply:

Thanks for your constructive comment. We had revised by adding a sentence "*The current version of the ROE model includes the crawler module for the from amap.com (also called the Gaode map) application (Figure 2), a widely adopted map application in China (additional details are provided in section 2.4.).*" to clarify the available data source in the current version of model in page 3, line 38-40.

4. p4 line 15 and section 2.2: More details on the emission factors building methodologies would be useful to appreciate their relevance in a near real-time / "instantaneous" framework. Does their temporal representativeness is fully consistent with the fine temporal description of the traffic data? If not, what are the expected impact on the results?

Reply:

Thanks for pointing out this. We had shown the emission factors and their correction factors in supplementary materials section S1. We had considered the traffic condition correction factors

(Table S9 and Table S10) when we calculated the on-road emissions. The emission factors are different under different traffic conditions and the classification of these traffic conditions are based on the real-time traffic data. These correction factors were clarified in page 4, line 22-25, "*The correction factors involving environmental conditions (e.g., temperature, relative humidity, and altitude) and traffic conditions obtained from the technical guide were considered in the study. They are listed in Tables S4–S10 in the supplementary materials. These correction factors were applied to reduce the effects of uncertainties associated with the emission factors.*"

Table S9. Traffic condition correction factors of petrol vehicle

	Traffic Speed (km/h)				
	<20	20–30	30–40	40–80	>80
CO	1.69	1.26	0.79	0.39	0.62
HC	1.68	1.25	0.78	0.32	0.59
NO_x	1.38	1.13	0.90	0.96	0.96
$PM_{2.5}$, PM_{10}	1.68	1.25	0.78	0.32	0.59

Table S10. Traffic condition correction factors of diesel vehicle

	Emission Standard	Traffic Speed (km/h)				
		<20	20–30	30–40	40–80	>80
CO	Pre-China I to China III	1.43	1.14	0.89	0.84	0.61
	China IV, China V	1.29	1.10	0.93	0.70	0.61
HC	Pre-China I to China III	1.41	1.13	0.90	0.61	0.41
	China IV, China V	1.38	1.12	0.91	0.64	0.48
NO_x	Pre-China I to China III	1.31	1.08	0.93	0.74	0.66
	China IV, China V	1.39	1.12	0.91	0.60	0.28
$PM_{2.5}$, PM_{10}	Pre-China I to China III	1.22	1.08	0.93	0.71	0.49
	China IV, China V	1.36	1.12	0.91	0.65	0.48

5. p5 line 33: The table 2 only shows the global results without any analysis. I guess a comprehensive comparison of the three inventories is beyond the scope of the current paper, however some general considerations and analysis concerning the discrepancies between the three database appears mandatory for this manuscript.

Reply:

Thank you for your helpful suggestion. We had added some details about the MEIC and PRD inventories. In page 6, line 29-34, "*These two emission inventories used the top-down method to establish on-road emission inventories. Unlike the bottom-up method used in this study, these two inventories first calculated the total emissions based on the VKT data of vehicle categories. In the MEIC inventory, the total number of vehicles was obtained from the relationship between total vehicle ownership and economic development (Zheng et al., 2014), while the PRD inventory acquired information on the number of vehicles from the city-level statistics Yearbook. Then, the spatial distribution of these two inventories was established based on the road network density.*"

According to the uncertainty analysis of emission factors, the uncertainty of $PM_{2.5}$ and PM_{10} is much smaller than the gaseous emissions, leading the large difference of gaseous emissions.

As for NO_x emissions, we thought that the higher NO_x estimate could be due to our updated LPG bus emission factor based on the local study (Zhang et al., 2013). The NO_x emission factor of an LPG-fueled bus is 1.7 times that of a diesel-fueled bus. This maybe one of the reasons leading the higher NO_x estimate. From figure 9, the results showed that the NO_x emission distribution of bus in urban and suburban area was 20.5% and 10.8%.

We had added this content in page 6, line 38 to page 7, line 4, *"the difference of $PM_{2.5}$ and PM_{10} amount was smaller than other gaseous emissions among different inventories. This was because that the uncertainty of particulate matter emission factors was lower than the corresponding values of the other emissions, which led to the large difference for the gaseous emissions and the smaller differences for $PM_{2.5}$ and PM_{10}. For NO_x emissions, however, this study showed a higher NO_x estimate than that in the other two inventories. One of the reasons for the higher NO_x estimate may be the application of the updated LPG bus emission factors in this study. Based on a previous local emission factor study, the NO_x emission factor of an LPG-fueled bus is 1.7 times that of a diesel-fueled bus in Guangzhou (Zhang et al., 2013). The results in Figure 8 show that the NO_x emissions distribution attributable to buses in urban and suburban areas were 20.5% and 10.8% of the total NO_x, respectively, showing that the LPG-fueled buses may be responsible for higher NO_x estimates in this study compared to those in the other two inventories."*

6. p5 line 35 and followings: The numbers provided in tables should not be recalled in the body text.

Reply:
Agreed. We had deleted it in section 4.1.1.

7. p7 line 14-15: From section 3 I understand the "boundary conditions" are considered to feed the MUNICH runs. It implies that other sources than on-road emissions are implicitly considered.

Reply:
Yes. The "boundary conditions" represented the "background concentrations" from outside the simulation street network. To make it understand more easily, we had changed the "boundary conditions" to "background concentrations" in page 6, line and line 21.

8. p8 line 35: One of the traditional aim of models is to be used for prospective (long term forecast) studies. Could the authors provide some hints on how their methodology could be extended too perform such study?

Reply:
This is a good point. In discussions and conclusions part, we had discussed the possibility of applying the street-level air quality model in forecasting the variation of pollutants. In page 10, line 24-28, "*Recently studies had shown that traffic forecasting models are effective within cities (Min*

et al., 2009; Cortez et al., 2012; Vlahogianni et al., 2014). These models allow one to obtain predicted traffic-based on-road emissions. Combined with the meteorological forecasting systems and regional air quality forecasting systems, which provide the meteorological and background concentration predictions, respectively, street-level air quality models could be used for street-level air quality forecasting as well.".

Reference

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