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Interactive comment on "Development of a real-time on-road emission (ROE v1.0) model for street-scale air quality modeling based on dynamic traffic big data" *by* Luolin Wu et al.

Anonymous Referee #1

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Review Comments on Luo et al. (GMD-2019-74)

Major comments

This paper describes a new emission model (ROE) that is based on the bottom-up approach and the intelligent transport system (ITS) in China and that can generate real-time high-resolution emissions from vehicles in Guang zhou area. It also describes the application of an urban street-network model, MUNICH, in Guangzhou area using the traffic emissions estimated by the ROE. Street-level emission and air quality modeling is an important and hot topic in atmospheric sciences yet technically and computationally challenging. This paper fits the scopes of GMD and EGU and addresses this very

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important topics. It represents one of the first applications of the MUNICH model in China. The approaches for the development of ROE and the application of MNICH are technically sound. The results are very interesting and illustrated the skills of MUNICH in simulating surface NOx and O3 concentrations in the Guang zhou area. The paper is well organized. The methodologies and results from ROE and MUNICH are overall well described, although more detailed and in-depth descriptions are expected in several places (see below and specific comments).

Several important revisions are needed to bring this paper up to the quality for publication in GMD.

1. More detailed descriptions on the development of ROM are needed. For example, what are the assumptions used? What are the uncertainties associated with emission factors? What are the limitations of the ROE that warrant future improvement? How is the ROE developed in this work different from that ITS work of Xiong et al., 2010 over Guang Zhou and also by other people over China? What are the innovative features and uniqueness of this work in the context of existing work?

2. How were the urban background concentrations be derived for the MUNICH model? What are the uncertainties/measurement errors associated with the measurements of NOx and O3 concentrations?

3. What are the model evaluation criteria (e.g., threshold values for the statistical metrics) used to judge the model performance? How are those statistics compared with other model evaluation for simulated NOx and O3 concentrations reported in the literature?

4. More in-depth discussions of emission modeling results are needed, e.g., the discussion for Table 2 that compares the three emission datasets. Why are NOx emissions estimated in this work higher than those from the other two? Why are the differences in gaseous emissions larger than those in PM2.5/PM10 emissions among the three inventories? Also, it would be useful to provide a brief description on the basis of

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MEIC-2016 and PRD-2015 inventories, which may help understand the differences across the three inventories.

5. More in-depth discussions of air quality modeling results are needed, e.g., discussion for Figure 11, why does the model give larger NOx overpredictions of NOx and O3 underpredictions on May 2? It looks that the model tends to overpredict O3 mixing ratios at night, could you please explain the likely causes for this overprediction? Does this error come from the overestimated urban background O3, or underpredicted NOx titration (as the model tends to underpredict NOx mixing ratios at night) or both? Is it possible to set up some sensitivity simulations to verify/pin-point your speculated causes for the model bias?

6. In the conclusion section, it would be useful to discuss the limitations of this work and future areas of improvement for both ROE and the MUNICH modeling work.

7. The paper contains some grammatical errors, typos, and undefined acronyms. Additional references should be cited in several places. It would benefit from an editorial review by an English-speaker.

In sum, this paper represents an important contribution to the street-level emission and air quality modeling. I would recommend the paper be accepted after the authors revise the paper to fully address the above major comments and the specific comments below.

Specific comments

1. Page 1, line 16, does “Mg/a” mean “Mg/year”? If so, I would suggest to use “Mg/yr”. A similar question for “Mg/a” in page 5, line 36.

2. Page 1, line 32, replace “has seen” by “has experienced”.

3. Page 1, lines 33-34, “Zheng et al., 2009b” should be cited after “Zheng et al., 2009a”

4. Page 1, lines 35-36, are those percentages concentrations or emissions of CO,

NOx, and HC? Please clarify.

5. Page 1, line 37, “Numerical emission modeling” (rather than “Numerical air quality modeling”) is “an effective method to estimate on-road vehicle emissions”, please correct this.

6. Page 2, line 13, replace “leads” by “lead”

7. Page 2, line 18, replace “heavy reliance” by “strong dependence”

8. Page 2, line 29, replace “observation” by “observational”

9. Page 3, lines 16-20, how is the ROE developed in this work different from that ITS work of Xiong et al., 2010 over Guang Zhou and also by other people over China? What are the innovative features and uniqueness of this work in the context of existing work?

10. Page 4, please discuss uncertainties associated with emission factors.

11. Page 4, lines 21-27, please explain why the Underwood volume calculation model was selected. This method was developed about 60-year ago, is it still better than more recent methods?

12. Page 4, line 41, replace “includes” by “include”

13. Page 5, line 1, “7:00-22:00” covers not only daytime but also nighttime, please clarify.

14. Page 5, after Section 2.4, it would be useful to discuss any limitation and uncertainties associated with the ROE model. Page 2, lines 41-44 indicated some issues with the ITS methods, are those issues applicable to the ROE developed for Guangzhou area? Also, what specific traffic information and emission factors will be needed if one applies the approaches/modules used in the ROE model to estimate real-time traffic emissions in other cities?

15. Page 5, line 12, which version of WRF was used?

16. Page 5, lines 18-19, why were only 31 main street segments selected?

17. Page 5, line 20, please spell out “WUDAPT”.

18. Page 5, line 24, why was “the 28th April 2018 to the 2nd May 2018” selected? This needs to be explained up front, not in a section later.

19. Page 5, lines 26-28, are “boundary conditions” the same as the urban background concentrations needed for MUNICH model simulations? How are the measured NOx and O3 concentrations used to derive the boundary conditions? What are the uncertainties/measurement errors associated with those measurements?

20. Page 5, lines 33-37 and page 6, lines 1-2. Please add some discussions on the comparison of the three emission datasets in Table 2, e.g., why are the NOx emissions estimated in this work higher than those from the other two? Why are the differences in gaseous emissions larger than those in PM2.5/PM10 emissions among the three inventories? Also, it would be useful to provide a brief description on the basis of MEIC-2016 and PRD-2015 inventories which may help understand the differences across the three inventories. Were MEIC-2016 and PRD-2015 based on the top-down or bottom up approaches? Can those differences be related to the limitations associated with the emission modeling methods discussed in page 2?

21. Page 7, lines 7-8, discussion for Figure 11, could you explain why the model gives larger NOx overpredictions of NOx and O3 underpredictions on May 2? It looks that the model tends to overpredict O3 mixing ratios at night, could you please explain the likely causes for this overprediction? Does this error come from the overestimated urban background O3, or underpredicted NOx titration (as the model tends to underpredict NOx mixing ratios at night) or both? Is it possible to set up some sensitivity simulations to verify/pin-point your speculated causes for the model bias?

22. Page 7, lines 7-16, a reference is needed for those selected metrics. What are

the criteria used to judge the model performance to be good? How are those statistics compared with other model evaluation for simulated NOx and O3 concentrations reported in the literature?

23. Page 7, line 11, “the model overestimated values”, do “values” mean “observations”? Please replace “a MB” by “an MB”.

24. Page 7, line 12, please remove “respective”

25. Page 7, line 13, please add “respectively” after “0.90”, replace “values” by “observations”, replace “a MB” by “an MB”.

26. Page 7, line 36, replace “As Table 5 shows” by “As shown in Table 5”

27. Page 8, line 12, replace “the emission” by “the emissions”

28. Page 8, line 42, replace “observation” by “observational”

29. Page 8, it would be useful to discuss the limitations of this work and future areas of improvement for both ROE and the MUNICH modeling work.

30. Page 12, Table 1, please provide the full name of acronyms such as RRTM, ACM2, UCM in the footnote and references for each module. Please also indicate the version of WRF used in the table title.

31. Page 13, Table 4, “RESE” should be “RMSE”. Please add a footnote to define all acronyms such as OBS, SIM, etc. to make the table self-explainable.

32. Page 13, Tables 5-6, it is not necessary to include “%” in all numbers in those tables. Suggest to delete “%” from all numbers in the tables and add “percentage” before “differences” in the title of the tables.

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