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Geoscientific Model Development Discussions

Interactive comment on "Multi-scale modeling of urban air pollution: development and application of a Street-in-Grid model by coupling MUNICH and Polair3D" *by* Youngseob Kim et al.

Anonymous Referee #1

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General Comments

This is a paper to describe the development of a new Street-in-Grid (SinG) model and its initial application over a Paris suburb. Because of their inherent limitations, most current regional air quality models cannot accurately simulate the pollutant concentrations at the urban street levels. On the other hand, very few urban street network models aiming at improving urban streel-level predictions of pollutant concentrations have been developed thus far. This work fills in this critical gap through developing an urban street network model (MUNICH) and bridging it with a regional air quality model (Polair3D), it thus represents a significant scientific contribution in urban air quality modeling. The

development of SinG is technical sound and represents the state-of-the-science. SinG should be applicable to other cities in the world and can improve not only the air quality predictions at urban scale but also the accuracy of human exposure and associated health effects. The paper is well written and organized. The assumptions used in the development of MUNICH were clearly stated. For its application over a Paris suburb, SinG showed enhanced capability in representing urban street-level concentrations of major pollutants such as NO2 and O3. I would recommend acceptance of this paper for publication on GMD with minor revisions as suggested below and in the specific comments.

It would be useful to discuss uncertainties (or inaccuracies in some input data) associated with the model formulations/assumptions, input data, and the boundary conditions estimated based on limited measurements that may contribute to the underpredictions in NO2 concentrations by MUNICH and Polair3D and in NOx concentrations by MUNICH, SinG, and Polair3D. In some cases, sensitivity simulations can help pin-point the causes and estimate the relative contributions of such uncertainties to the model bias (e.g., in the application of MUNICH to a Paris suburb.

Specific Comments

1. Page 4, Section 2.1.1 described two methods to calculate the turbulent vertical mass transfer coefficients, which one is used in SinG?

2. Page 6, there are large differences in the average wind speed calculated by SIRANE and MUNICH, which one is more accurate? Have they been evaluated with observations?

3. Page 7, line 23, change "photolyses" to "photolytic reactions"

4. Page 7, line 25, Leighton photostationary state may not hold in urban air when VOCs emissions are high (e.g., morning time), this needs to be pointed out.

5. Page 8, at the end of section 2, it would be useful to briefly summarize the main

differences between SIRANE and MUNICH, in particular the strength of MUNICH over SIRANE. Also, has MUNICH been evaluated against a CFD model?

6. Page 8, line 29, is 10-min sufficiently short to represent the interactions between urban street emissions and background. Under what cases, should a shorter or longer time should be used?

7. Page 9, lines 7-16, more details on the dynamic traffic emission model used should be provided. For example, what are the species emitted from the traffic? Why was only NOx emission considered in this work? What are the uncertainties associated with calculated traffic emissions? What are the unique aspects of the dynamic traffic emission model used, comparing to static traffic emission model? Can SinG use both types of traffic emission models?

8. Page 9, lines 13-14, "Surface areas of intersections are not taken explicitly into account in MUNICH", what impact will this have on the predictions from MUNICH? Can surface areas of intersections be accounted for in future work?

9. Pages 10 and 15, sections 4.4 and 4.5, which version of WRF was used? "Satisfactory results" sounds too vague. A brief summary of the meteorological performance with some quantitative measures (e.g., NMBs, FBs, correlations) should be provided. What are the meteorological variables evaluated using observations, does it include PBLH?

10. Page 12, lines 5-8, based on section 4.4, the meteorological performance is satisfactory, what specific meteorological data may still contribute to the large discrepancies in obs. vs. sim. NO2 concentrations? Is it possible to set up a sensitivity simulation to estimate the relative contributions from uncertainties associated with calculated traffic emissions? In line 5, add "uncertainties in" before "to the model formulation or the input"? Also, since measured conc. were used to set up the background conc., the uncertainties in measured conc. may contribute to the discrepancies reported here, this should be added to the list of possible reasons.

11. Page 12, lines 8-13 and page 14, lines 1-4. Given the importance of background conc. and a large uncertainty in the measured conc., it may be useful to set up a sensitivity simulation to estimate the relative contributions from the uncertainties in the background conc. derived from measurements (e.g., instead of using the mean of concentrations measured at two urban background stations, using the higher conc. observed at the two stations to set up the background conc.). At minimal, some discussions on the uncertainties in limited measurements used to set up the background conc. should be discussed.

12. Page 13, Table 1, need to define the configurations used SinG-s comparing to those used in SinG in the footnote of this table.

13. Page 15, line 2, which version of MEGAN was used?

14. Page 16, lines 5-6, could you explain the meaning of "quasi-total O3 titration"? Also, what did you mean by "more limited O3 titration" which sounds confusing? Did you mean less O3 titration in SinG comparing to Polair3D?

15. Page 16, lines 9-15, Figure 7 showed that SinG tends to overpredict NO2 conc. during several time periods, what are the likely causes for those overpredictions? What are the main reasons that change the underpredictions in MUNICH to the overpredictions in SinG?

16. Page 16, line 28, add a reference for "The turbulent transfer coefficient is decreased by 25%."

17. Page 17, Were MNE and MNB calculated against Polair3D or observations? A footnote should be added to clarify this.

18. Page 1, lines 12-14, Page 18, lines 9-11 and 24-26, this is true for the test case here, but may not be always true for other cases where the Leighton photostationary state may not hold (e.g., with high VOCs that breaks down this photostationary state, which may happen in morning urban air). The abstract and conclusions need to be

modified to reflect this important point. Also, a test application over urban street networks where VOCs emissions are high (Leighton photostationary state may not hold) should be conducted in the future.

19. Page 18, it would be useful to briefly discuss the appropriateness and applicability of the SinG over other urban areas worldwide and the implications of the SinG to the quantifications of the impacts of urban traffic emissions on air quality, human exposure, and resulting health impacts.

20. Table B1, 'The "O3 cor." corresponds to the ozone concentrations from the second simulation using "corrected" boundary conditions." Does the second simulation refer to "SinG-s"? if so, the correction is not just the boundary conditions of O3, there are additional adjustments, as described in Section 5.3. Also, the R values remain the same between O3 and "O3 cor." Runs, a brief discussion on the reason should be added.

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