Geosci. Model Dev. Discuss.,
https://doi.org/10.5194/gmd-2019-48-RC2, 2019

Geoscientific Model Development Discussions
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Interactive comment on "CALIOPE-Urban v1.0: Coupling R-LINE with a mesoscale air quality modelling system for urban air quality forecasts over Barcelona city (Spain)" *by* Jaime Benavides et al.

Anonymous Referee #2

Received and published: 25 March 2019

This paper deals with the CALIOPE-Urban model system that couples regional scale atmospheric chemistry transport calculations with the urban roadway dispersion model R-LINE to represent the spatial distribution and temporal variability of NO2 concentrations in cities. A new concept to adapt R-LINE to dense urban areas is introduced, consisting of an urban background scheme, a vertical mixing parametrization considering atmospheric stability and building geometries and a surface roughness parametrization to estimate turbulent dispersion in street canyons. The paper is clearly structured and the new concept is well documented for the most part. Results from the model evaluation with different monitoring datasets obtained in Barcelona are convincingly presented. Specifically, the coupled system overcomes two major challenges of the downscaling of regional model results to local scales, namely the adjustment of mesoscale meteorological data to street level and the retrieval of background concentrations from the regional model avoiding double counting of traffic emissions. My main concerns are with regard to two aspects of the new concept. First, it is claimed that atmospheric stability influences the relation between rooftop concentrations and the concentrations at street level (e.g. p. 11, lines 8-11). While this well may be the case, no independent evaluation of the influence of atmospheric stability on the vertical concentration profile in street canyons is given in the paper. The authors should either refer to previous studies in Barcelona or show an evaluation based on own measurement data. Second, the model system shows poor skill when the observed wind speed is low. I would expect that the traffic-induced turbulence dominates the turbulence in street canyons at low wind speeds. However, it seems that turbulence generated by the moving traffic is not included in the parametrization. Calm winds potentially lead to highest concentrations and can cause severe pollution episodes. Hence, it would be crucial for a street canyon model to cope with low wind situations.

Specific Comments

1.) P. 2 line 9-21: In this part of the Introduction, several systems coupling regional and urban scale models are described. It would be better to divide this presentation into (1) systems that apply nesting of an urban scale model within a regional scale model and (2) regional scale models that apply downscaling (using a dispersion kernel). The given examples from literature are not exhaustive. Also mention a second method for downscaling, by embedding Gaussian dispersion models within the grid.

2.) P.4 line 1: How representative is this period (April and May 2013) for the season? Why was such a short period chosen?

3.) P.5 line 26-27: Why were the 38 vertical layers from WRF collapsed to 15 layers for the CMAQ computation? With only six layers in the PBL, this leads to a rather crude treatment of the near-ground chemistry and boundary layer mixing processes.

4.) P.4 line 1: Please provide a list of the chemical reactions in the GRS here.

5.) P. 7 line 3 and P.12 line 4: Several of the empirical parametrizations in this paper have been calibrated with NO2 measurements (parameters C and m). This raises the question about independence of the calibration data. Was the calibration done with an independent NO2 dataset, not used in the presented model evaluation?

6.) P.7 line 25: Wind channelling may not occur in streets that are relatively short. The validity of the channelling effect should be analysed for street network of Barcelona.

7.) Section 2.3.3: The large scale model grids are step wise in nature. This could lead to significant edge effects caused by the concentration steps between the CMAQ grid cells. How is this considered in the UBS when applying bilinear interpolation to provide background concentrations at the receptors? The error of the background concentrations at low wind speeds should be estimated.

8.) P. 11 line 10: Does wind channelling affect the ratio ws_sfc/ws_bh?

9.) P.12 line 5 - 10: Determination of the surface background concentrations needs more explanation. An illustration of the surface background concentration as function of building density would be helpful for understanding how it is derived from the rooftop background under different stability conditions.

10.) P.15 line 11 - 12: Which QA/QC procedure was in place for the monitoring with passive dosimeters?

11.) Table 3 and Figure 8: Measurements at station Gracia-Sant Gervasi are underestimated by all three model configurations in the daytime between morning and afternoon rush hours. Table 3 shows a positive bias for CALIOPE-urban-nl (marked as best performance for MB at this site), but this is deceiving since Figure 8 shows that overestimation at rush hours increased the bias. Obviously, the traffic increment is not correctly represented at this site. Could this be caused by the missing contribution from recirculation of traffic exhaust?

12.) P.19 line 9 and Figure 8: Give the possible reason for the afternoon underestimation of NO2 concentrations at sites with low traffic. The underestimation of NO2 in the afternoons could also be linked to photochemical conversion. Therefore, I recommend to repeat the plots of Figure 8 for NOx concentrations.

Technical Corrections

P. 6 line 8: “This approach addresses” fits better.

P.15 line 12: In every km2 grid cell?

Figure 11: It should be mentioned in the figure caption whether the resolution is 10m x 10m for the entire concentration map or only in the 250m buffers along streets.

Figure A1: What explains the zero values for the aspect ratio values in the scatterplot?

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Discussion paper