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Geoscientific Model Development Discussions

Interactive comment on "Development of the city-scale chemistry transport model CityChem-EPISODE and its application to the city of Hamburg" *by* Matthias Karl

Anonymous Referee #1

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The paper presents the extension of the urban dispersion model EPISODE in order to more accurately calculate air pollutant concentrations at high resolution, in particular for photochemically active species (NO2 and O3). The model consists of a Eulerian grid and a receptor subgrid model and includes modelling of the street canyons and point sources. The impact of boundary conditions, vertical mixing and photochemistry were tested with an idealized set-up and the model was applied for the city of Hamburg with detailed emissions, meteorology and compared with in-situ observations. The new model is called CityChem-EPISODE The work is in general of good quality and the model developments and simulations are described in detail with thorough knowledge of physical and chemical processes. The material would nearly be enough for two

papers and sometimes I got lost in the wealth of information. Most of it is there but not always where I expected it. Therefore I will put some suggestions to help the reader. In particular a good table with an overview of the settings used in the test cases would make it easier to read. What I missed is a discussion on the influence of ozone and PM boundary conditions on modelled concentrations for Hamburg. How good were the input BC from CMAQ? What I also missed is a perspective of how well other models perform to place the results in a better perspective: how much would you gain by implementing the proposed improvements? This would also help the reader to make a choice to start using this model or wait for a next version.

Abstract

Here I missed a clear statement of what is new and what is the use (like first sentence of p3: It's purpose..) and a summary of the model extensions/modifications (as found on p4). The areas of improvement can be mentioned but are less important here I would say.

1 Introduction

After the general introduction (till line 23) I would first explain what CityChem-EPISODE adds to existing models in terms of detail (resolution and chemistry) and efficiency, thus following the line of reasoning from nested models and presenting the (expected) benefits of this model. Only after that I would go into detail. I also miss a motivation to present the current version of this model, as the list of future improvements is still considerable. What is the status of the current version?

2 Description of the CityChem-EPISODE components

I miss a good description of the vertical structure of the Eulerian grid model: how many layers, depth of lowest layer,top height, typical horizontal resolution, size of the domain, lonxlat grid or equidistant? P8 l1 I would rather say idealized test simulations, not artificial

P12 l9: why Delta X/2? I do not understand the moving of receptor point related to the 'cut section'(Figure 4).

P12: I am confused between 'every advection step' and 'changes for the next simulation hour', advection steps are smaller than one hour.

13 l10 What kind of auxiliary input?

Which meteorological fields/variables are used? How easy would it be to make interfaces to other boundary conditions?

3 Performance of the chemistry-transport coupling

I do not understand whether it is a 9x9domain with 1x1 grid cells or a larger domain with 9x9 grid cells. A single table with test settings for all experiments would be very helpful.

P14l24 Linear fit of what?

P14l30 area emissions: what is unit of area here?

P15: sometimes ppbb is used and sometimes μg/m3, it would help to be consistent.

P15l10: steep gradient?

P15 last paragraph: the first two reasons to prefer the scheme are not following form this paper, only the third is demonstrated with the tests.

P16 I think that it is more common to speak of VOC or NOx-limited regimes. Which boundary conditions and mixing scheme do you use for the chemistry test? Why take production rate from the fifth day? The test seems a mixture between a box test and a test in a transport model. It would be interesting to see how it performs in comparison with the original EmChem.

P16l15: explicitly mention that NO2 concentrations are high in cities

P18l9 Not only results are in Table 4 but also essentials about emissions.

4 Application to Hamburg

Which boundary conditions from CMAQ were used? Were secondary organic and inorganic aerosols (SOA, SIA), seas spray and dust included as PM10 input?

P18l26 inner domain of a nested

P18 Why was TAPM chosen as a meteorological driver? Why was input on boundary not taken from COSMO-CLM?

P20 How does TAPM perform for rain?

P21 Inflow from boundaries is very important for such a small domain. How well does CMAQ perform for this area? Uncertain anthropogenic emissions in urban area are part of the story.

P24l24 densely populated area.

P24 How good is O3 inflow from CMAQ? Is will dominate the baseline concentration, in particular in winter.

5 Planned improvements

P27l16 This would be a good sentence for the abstract/introduction

P27l18 These four areas do not clearly follow from the paper: there was no attention for wet deposition, SIA and SOA was hardly mentioned. Discrepancies were rather ascribed to emission uncertainties in the analysis. Given the local scale of the model, it may be more relevant to look at the inflow of SIA and SOA as gradients in these species are not so strong. VOC emissions from trees may however be relevant in the VOC-limited regime, and also the identified problems with NO2-photolysis would deserve attention here. If all the proposed model improvements are included, would it not make the model too heavy and too similar to other existing models (including plume in grid approach with SCICHEM)? What are the characteristics typical for CityChem-EPISODE that you would like to keep? I would expect something on the specific strength of the

model as compared to existing models.

6 Conclusions

P29l21 One would expect the best results for PM10 at traffic stations, as the relative role of primary pm is larger there and one would benefit most from increased resolution.

Figures

Figure 2: does this figure correctly represent the ratio between receptor points and Eulerian grid?

Figure 3: For receptor points. . .

Figure 7: What are the triangular structures downwind on the diagonal?

Figure 8: Figure a looks strange, inner domain CD4 nearly cuts Hamburg.

Figure 9: Would be nice to have species indicated in the plot titles, same holds for other figures.

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