

General vote

With regard to increasing urbanisation and connected air pollution, improving air quality models in urban areas gets more and more important in order to understand the complex interactions between physical and chemical processes in these highly dynamic environments.

The existing paper nicely presents a regional WRF-Chem modelling study for the urban area of Berlin discussing the model sensitivity to varying resolution and different input data. It is well structured and written in an understandable way, which makes it easy to follow and get the aim of the work. The relevance for the scientific field is given on the one hand by using a novel methodology coupling a modified version of the WRF Urban Canopy Model to WRF-Chem and further relating to existing relevant studies in the field.

Before being suitable for publication in 'Geoscientific Model Development' however some important points have to be clarified and discussed further, which are mentioned in the following:

General concern

Could you please justify the use of the single layer urban canopy model (SLUCM) instead of the more complex multi layer approach BEP. If I am not wrong, the BEP allows for a higher vertical resolution to the ground and therefore might be more suitable to discuss 'ground level concentrations' in urban areas. It would be nice at one point to give more details on the vertical resolution. Using the SLUCM would mean that your lowest model level would be located at the level of the mean building height defined in the parameter table, which could lead to significant discrepancies when comparing simulated concentrations with local air quality observations. I guess the underestimation of PM10, PM2.5 and NO might be partly to the fact, that the lowest model level is too far away from the emission source/measurement height, so that a certain amount of pollutants already have been dispersed by vertical mixing.

In my point of view, this aspect has to be mentioned and discussed somewhere in the paper.

Minor review points are listed below on a line-by-line basis:

Page 1:

13: specify the characteristics of the 'base run'

14: more information on the term 'mosaic option' needed. The benefit/aim of using this approach is not really clear.

Page2:

28: What is the expected benefit in using the SLUCM? Would BEP also be an option as well. Please discuss this aspect in the proceeding of the study.

Page 3: 'Among[...]' : please check language

Page 4:

6-9: At this point you mention the multi-layer model BEP used by Fallmann et al. (2016). Please discuss, why you have chosen the SLUCM for your study.

29: Please provide information on your vertical resolution.

Page 6:

1: What do you mean with 'default input parameters'? US-City? Where are they originated from?

7: How did you calculate the mean building length in QGIS? Did you use all the buildings within the city's vicinity? Was there an algorithm? Please describe briefly.

24: How is the distributions improved around cities? Is there literature on that?

26: height of the first model layer?

Page 8:

3: Indicate briefly why a second quality control is needed and how it is achieved.

6: better: 'specific humidity data'

7-15: Was the calibration and quality check of the sensors part of the study? What is meant by visual inspection? Maybe you can leave out 11-14..

17: The Lindenberg station is located in some distance to the urban area of Berlin. Please discuss why the profile data is suitable for your approach as the SLUCM only works for urban areas and modifies the local meteorology there. Additionally, the Lindenberg profiles start in a height which is located over the mean heights of the buildings I guess. With regard to Fig. 5, especially during noon, the model overestimates the observed temperature by 2-3 degrees. Please provide some discussion on that in later chapters (Chapter 3.2.2)

Page 10:

1-17:

What is the model reference height for comparisons? For primary pollutants in particular, there is a rapid decrease in concentration with height due to mixing, deposition and chemical reactions. This effect in addition to the fact that you are comparing a grid cell to a point measurement might be the predominant reason for an underestimation. Please provide further discussions on that point in later chapters.

23: The simulated 2m temperature is not the actual temperature, but a diagnostic variable in your WRF-Chem setup, correct?

Page 11:

2: The negative bias in that study could also be related to the vertical resolution.

3: see above

8-10: Please describe more into detail.

14: 2m temperature?

21ff: The general ability of your WRF setup to reproduce the meteorology of a 'non-urban' station does not reveal a lot about the models skill in the urban area of Berlin. Please see previous comment for Page10 Lines 1-17

Page 12:

4: is it possible to show the ceilometers observations?

6: On which basis is the MLH calculated in YSU?

Page 13:

19: '..the chemical mechanism itself..'

29: Vertical resolution could be main source of error.

33: better: tends to be most pronounced...

34: why?

Page 14:

13: Can you see a relation between NOx and O3 with regard to photochemical reactions?

Page15:

2: see above (vertical resolution)

10: '...and resolution'

Page 16

17: wind speed in which height?

30: better: 'bias is reduced'

Page 17

5ff: Please discuss at that point the effect of vertical and horizontal resolution as well.

22: mention vertical resolution

Page 18:

24: Specify the height of the first model level.

6 Summary and Conclusion

As mentioned in previous points, the only point of concern which is consistent throughout the study is the vertical resolution and the connected errors in reproducing the pollutant concentration close to the ground. For a sensitivity study looking at differences between similar model configurations this might not be much of a problem, but at least has to be discussed more detailed. I was wondering if 'better' results would have been achieved when using BEP instead. I know that the mosaic approach does not exist for the BEP. It would be interesting to quantify the effect of using a modified SLUCM (mosaic) in comparison to BEP to get a feeling of the sensitivity towards the urban canopy scheme.