

Review for paper:

“The urban dispersion model EPISODE. Part 1: A Eulerian and sub-grid-scale air quality model and its application in Nordic winter conditions”

by

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Submitted to Geoscientific Model Development

General Comments:

This paper presents a Eulerian urban dispersion model, EPISODE, which consists of a 3D CTM including sub-grid dispersion modules. Such a model is essential for estimating the exposure of urban populations to pollution. First, the authors describe each component of the model, and second, they assess the capability of the model to simulate NO₂ levels over six cities in Norway. However, some parts of the paper is not very clear or incomplete or, in my opinion, not necessary regarding the aim of the paper. This leads the paper very long with numerous tables and figures.

Overall recommendation:

I recommend that the paper should be accepted for publication in Geoscientific Model Development after major and specific revisions listed below.

Major Revisions:

First, I suggest an effort to shorten the paper and limit the number of tables and figures for more clarity.

My second main concern is about the meteorological drive of EPISODE. I understand that the 3D part of EPISODE is a CTM and I think it is necessary to explain how the meteorological inputs are provided to EPISODE and at which temporal frequency. I guess that several options are available. However, Only two are briefly described and one in an obscure way (I don't know what is TAPM).

Third, in my opinion, the assumption of PSS could explain some discrepancies between simulated results and observations. However, this is not discussed except in the last part on future work.

Specific Revisions:**Introduction:**

- The discussion on LES modelling is very short and lacks from citations and examples of obtained results with such models.
- Others models using the same concept than EPISODE have been cited but no comparison is done between them and EPISODE. In particular, the originality of EPISODE compared to these previous models should be assessed.

Part 2:

- 2.1: I understand that no chemical evolution of PM_{2.5} and PM₁₀ is implemented in EPIDOSE but I wonder if microphysical processes (coagulation, sedimentation) are taken into account. At which time-step, the meteorological inputs are given to EPISODE?
- 2.2.1:
 - I understand that horizontal and vertical resolutions are flexible depending on the choice of the user. Could you please give the available range of horizontal resolutions and the typical number of vertical levels?

- Page 7, lines 16-18: the information about topography should be moved page 5 in the first paragraph after 2.2.1 when the vertical grid is detailed.
- Page 8: equations are hard to read, the font is too small. In equation (2), I guess it is $K_*(z)$ and not $K(z)$.
- Page 9, lines 7-10: could you please explain that the surface roughness is needed to compute the friction velocity?
- In table 2, it is indicated that constant concentration profiles are given as ASCII files while it is mentioned in the text (page 10, line 3) that they have to be specified in the EPISODE run file.
- Page 10, line 13: what are the NBV and BedreByLuft projects?
- Page 10, lines 17-18: it is indicated how the background concentrations are provided to EPISODE in the example presented in part two of the article but not for the one presented in part one.
- Page 11, line 6: please indicate how $J(\text{NO}_2)$ is computed, in particular the actinic flux.
- Concerning the PSS via R4, the authors should specify that it is adequate in polluted Nordic wintertime conditions especially during the day. Indeed during the night, the N_xO_y (including N_2O_5 , NO_3 and HNO_3) chemistry should be dominated.
- 2.2.2: Page 11, lines 28-31: I do not understand how the location of the road links is given to the model.
- 2.3: This section should be carefully read, it is difficult to understand, for instance:
 - UECT is described in two separated paragraphs.
 - What is TAPM?
 - I do not understand how it is possible to use 3D meteorological fields from AROME or WRF in EPISODE. I guess it implies a pre-processing of these fields to use then in EPISODE. Could you please clarify this point? Also at which temporal resolutions, meteorological fields have to be provided to EPISODE? See also major comment for this point.

Part 3

The information about the temporal frequencies of meteorological outputs given to EPISODE from AROME is missing. Why do you not use point source emissions? Could you please justify? I suggest adding a figure showing the location of the chosen urban areas including each domain of simulations if possible. The information about the vertical grids and the horizontal domain extend should be given at the beginning of the part and not at the end (table 6).

Part 4:

- 4.1.1: I'm not sure that this part provides interesting information regarding the aim of the paper. I suggest deleting it to shorten the paper. If the decision is to conserve it, could you please discuss the interest to provide annual mean concentration maps? Maybe this information could be relevant for abatement strategy?
- 4.1.2: The limitation due to the PSS hypothesis should be discuss in regards to the N_xO_y chemistry occurring during night (see comments on part 2.2.1).
- 4.1.3: I am not convinced of the interest to look at these kinds of differences. In particular, the use of mean values makes it difficult to separate processes that may explain differences between simulations and observations. Moreover, again, the effect of the PSS hypothesis and of the non-linearity of atmospheric chemistry, which is not taken into account, is not discussed.

- 4.2.1: Could you please give some possible reasons for this polluted event?
- 4.2.2: Same comment as 4.2.1

Parts 5 and 6: I suggest combining parts 5 and 6 in a part called "conclusion and future work".