Geoscientific

Model Development

Discussions

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Interactive

comment

Interactive comment on "An urban large-eddy-based dispersion model for marginal grid resolutions: CAIRDIO v1.0" *by* Michael Weger et al.

Anonymous Referee #1

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Dear authors,

This manuscript represents a novel large-eddy simulation (LES) model based on the diffusive interface approach. The main interest is in urban pollutant dispersion on the mesoscale. The manuscript contains an exhaustive description of the model equations as well as results on modelling different phenomena on varying scales. The main objective in model development has been on reducing the computational costs, which in general are high for urban LES studies.

Overall, the manuscript is well prepared and the representation scientifically sound. However, I have some major comments related to the readability and aim of the

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[Discussion paper]

manuscript:

1. The manuscript is rather long, which was already pointed out by the Editor. In my opinion, one solution for this could be to divide the manuscript in two, e.g.: 1) a more simple and concise model description manuscript with a simple evaluation study and 2) a manuscript presenting some atmospheric applications and sensitivity of the model. Now the model evaluation (Section 3) contains five different studies. Yet, only the comparison to the Michelstadt wind tunnel experiments (Section 3.4) represents a model evaluation. Section 3.2, instead, illustrate the model sensitivity. The rest of the studies illustrate the applicability of the model, but it is impossible to say how well does the model perform. Also, I think the annulus advection test might not be the most suitable one for a geoscientific journal.

2. The model description part of the manuscript is rather exhaustive and sometimes some variables are not introduced in the close vicinity of the equation. Please check these. You could also think if you could come up with some illustrative figures for this section.

3. The objective to limit the computational costs of an LES model is very important. However, one should keep in mind what is the aim of the application. For instance, to resolve the flow in urban street canyons and courtyards, a spatial resolution of ∼1 m is needed in order to directly resolve most of the energy and keep it LES. This should be emphasized in the manuscript. Furthermore, I find the first line of the abstract misleading. High spatial resolutions are needed to ensure accuracy in urban LES and to keep the amount of energy resolved by SGS terms small.

4. The language needs revision.

Additionally, find below some minor comments. P indicates page and L line.

- P1 title: "large-eddy-based" does not mean anything in my opinion. I would change it to "large-eddy-simulation-based"

- P1 L5: Why not also vertical resolution?

- P1 L13-14: I should be stated here whether the evaluation was successful or not.

- P1 L19: I do not think you can say that the PBL mixing processes can be well parametrised for urban areas...

- P1 L20-23: There is something missing in this phrase. Now it indicates that "providing more representative forecasts for individual locations" would be a research purpose.

- P2 L55: add "e.g." for the reference to Maronga et al. (2019), since the preceding statement about LES is not initially from this specific publication

- P2 L59-60: To conduct obstacle-resolving LES in urban areas, a spatial resolution of ∼1 m is needed (see e.g. Xie, Z., Castro, I.P. LES and RANS for Turbulent Flow over Arrays of Wall-Mounted Obstacles. Flow Turbulence Combust 76, 291 (2006). https://doi.org/10.1007/s10494-006-9018-6). Also, "less than 10 m to 20 m" sounds weird.

- P4 Eq. 1: Introduce u

- P5 Eq. 4: Introduce theta (yes, theta_v has been introduced)

- P6 L156: Typically, the continuity equation is referred to instead of the "divergence-free criterion"

- P6 L163-164: the notation "z=const" is unclear. Maybe simply "z is constant".

- P6 Eq. 13: Introduce A and V.

- P7 Eq. 15: the notation f was already applied for the Coriolis term

- P7 L189: z and x should be in italics

- P9 L225: I would but "mod 2" inside a parenthesis

- P9 L226: remove "it is" before "r = " and introduce j

- P10 Eq. 24: what does "Limods" indicate?

- P11 Eq. 28: It is not clear how this is derived

- P11 L281: "a first-order accurate in time Euler method" should be rewritten

- P11 L287: solve –> solver

- P11 L288: st and nd in 1st and 2nd should not be in italics

- P12 L294: is G used somewhere?

- P17 Eqs. 42-43: The transition from the Eq. 42 to Eq. 43 is very unclear.

- P25 L565: If you want to evaluate the model, it would be a good idea to plot also the results of the original study by Wicker and Skamarock (1998).

- Section 3.4: The description of the wind tunnel experiment can be shortened as it has already been published in Baumann-Stanzer et al. (2015).

- P28 L642-644: Give a reference for this phrase.

- P30 L646: If only the continuously emitting mode is used, why to mention the other at all here?

- P30 L650: The acceptance limits are originally from Hanna, S. and Chang, J. (2012): Acceptance criteria for urban dispersion model evaluation, Meteorol. Atmos. Phys., 116, 133–146, https://doi.org/10.1007/s00703-011-0177-1

- P30 L663: remove "of" after "Instead"

- P34 L718: is "u/s" the correct unit here?

- P34 L729: remove "range"

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