Topical Editor Decision: Publish subject to minor revisions
(review by editor) (26 Apr 2021) by Ignacio Pisso

Comments to the Author:
Please address the two minor comments of the reviewer:

Dear topical editor,

We are sending you our answers to the reviewer comments below in the form of individual points. We have also uploaded the revised manuscript updated according to the reviewers comments and the track-changes file. The changes are located on lines: 78, 129-130, 140-141, 597, 857-860, 1006-1008, 1263, and in Figure 9 and its caption. We would like to thank you for all your time and effort dedicated to this review process.

With kind regards,

Jaroslav Resler
(on behalf of all co-authors)

I find the revised manuscript improved, easier to read and follow. The authors have considered my comments and I have now only two minor comments below for the authors and some corrections to the text.

1) The authors answered to my comment n.3 writing that "…we are convinced that the global effects of the discretization cannot be neglected in some cases as the step-wise representation of the surface causes e.g. significant change of the surface area, roughness length, normal angles, mutual visibility, etc.."
Their rotation test shows indeed that there is an effect on heat fluxes in the most extreme case of a rotation of 45 degree for a flat surface. However, in my opinion the rotation test included by authors show a very partial view and I remark what I expressed in my original comment:

- *a) The error in the simulation is mainly induced by the radiative model not the LES flow model, i.e. not by the mask method in LES but by the stepwise representation in the radiative transfer model. The correction of geometry for the radiative transfer model can be done irrespective of the representation of the geometry in the LES. Therefore, the change in the representation by using IMB in the LES flow solver mentioned in 6.2, line 1006, is somewhat unrelated to the present issue.*
- *b) The effects discussed by the authors will become quickly negligible when the resolution of the model approaches the uncertainty in surface representation, i.e. what in the model appears as a flat surface is in reality characterized by protruding objects (e.g. balconies, windows frames etc.., see also e.g. figure 22 top-left) that have sizes of the order of a meter or so. The uncertainty in the representation of the surfaces is likely comparable to the error induced by the discretization as soon as the resolution in the model is of the order of about 1 meter.*

I mention that the new detailed discussion in sect 5.1.5 explains that the unrealistic spikes in the modelled temperatures (e.g. Fig. 11) can be mainly attributed to the DEM used for the buildings not being sufficiently accurate, this seems to confirm the view that I expressed above in point (b).

We consider our view on these matters not too distinct from the reviewer's one and we would not like to argue about this issue. We would like to mention the beginning of our answer to reviewer comment 3: „*We agree with the reviewer that the effect of step-like surfaces on the flow is mainly via the surface heat flux and thus in the radiation and the surface energy balance, while the direct effect on the flow is probably only of local nature; we added this to the text.*" On the other hand, the explicit quantification of the direct effects of the surface representation by the orthogonal grid structure on the LES flow neither follows from our work nor is it precisely done in the literature to our knowledge. We consider it a topic of future research (as we mention in our answer). For this reason we would like to avoid any speculations in this direction in the text of the current paper.

Point a): The PALM model is an integrated model where the individual processes share most of the data structures and we consider that as one of the strengths of this model. The data representation of the slanted surfaces thus also will be shared across all affected processes (RTM, USM, LSM, and LES). The reviewer is right that the formulation on line 1006 is unfortunate and can suggest that the central point of this enhancement is the representation of the slanted surfaces in the LES module. To avoid this possible misinterpretation, we reformulated this sentence and we replaced the citation of the particular IBM approach for LES by the general term "arbitrarily oriented surfaces" which is applicable for all affected processes.

Point b): If the grid spacing does not allow the resolution of small-scale surface objects, also reflections and mutual visibility on these scales cannot be represented either. In this regard, we agree with the reviewer that the error made by the step-like approach can be of the same order as the error made by non-representation of subgrid obstacles. To some degree we even expect that errors made by these effects may partly compensate for each other, though we emphasize that this is just speculation and we need to quantify this in the future.
However, when we look on relatively smooth facades, natural terrain, or slanted roofs without any significant objects, the error of non-representing subgrid obstacles is negligible, whereas the error made by the step-like surface representation is a pure misrepresentation of the model. To quantify all these effects, also in conjunction with the misrepresentation of small-scale surface objects, further research is required in the future.
As our study was not designed to investigate these issues and thus our results do not sufficiently support this issue, we would like to avoid direct statements of this type in the manuscript. To address this comment, we reformulated the corresponding paragraph of section 6.2 which is referred to at the end of section 5.1.7. As was mentioned in the answer to point a), we reformulated this part in a way which expresses better that the main goal for this model enhancement is to tackle discretization issues in the energy related processes which is consistent with the findings described in section 5.1.7.

The last paragraph of this reviewer comment touches the problem of the uncertainty of the input data which is another interesting issue. In our opinion, the main result presented in section 5.1.5 is the finding that these surface temperature spikes are realistic in their magnitude and general shape. The spatial and temporal discrepancies can be probably attributed to the impreciseness of the DEM used and caused mainly by the existence of objects on the roofs, which are not included in the DEM but which can cause shading (e.g. air conditions, balusters, and other "soft" objects). Some part of the discrepancies can be also caused by the discretization process. The DEM model itself is based on the official Prague Open Data (see sect. 3.2 and https://opendata.praha.eu/en/), it has a resolution of about a half meter. The data have been improving so DEM imprecision should not be the main issue in the future and the main problem seems to be in the above mentioned “soft” objects. But this particular issue is a part of a more general problem of the uncertainty of most of the model input data and parameters. The influence of these uncertainties on the model results is systematically studied in another manuscript of this special issue - Belda at al.: Sensitivity analysis of the PALM model system 6.0 in the urban environment.

All these reviewer comments touch partial issues which are very interesting and worth studying individually deeper in the future. We consider other more detailed or specialised discussion of any of these particular problems outside the scope of this work and of this manuscript. Nevertheless, we thank the reviewer for this discussion and all his/her comments, which not only helped to improve the manuscript itself but also influenced the aims of our future research.

2) Figure 9, please add the Kolmogorov inertial range scaling in the figure for reference.

We added Kolmogorov’s -5/3 law as a dashed line for reference. Within the inertial range the LES spectra agree well with Kolmogorov scaling, whereas we can observe a sharp drop-off at higher frequencies that correspond to smaller spatial scales. This is a well-known behaviour that can be mainly attributed to numerical dissipation accompanied by the advection scheme (acting up to scales smaller 10 times the grid spacing) as well as to the subgrid-scale scheme.

Text corrections.

Line 78, remove “complex” does not seem appropriate.
Done.

Line 129, 140. Rewrite the sentences removing “Important”, it seems unnecessary.
Done.

Line 597,”5.1.5” not “5.1.3”.
Fixed

Line 860, I do not think that “expedient” is the correct word.
The word “expedient” was replaced by the word “appropriate” and all this sentence was reformulated.