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Geoscientific Model Development Discussions

Interactive comment on "Vertically nested LES for high-resolution simulation of the surface layer in PALM (version 5.0)" *by* Sadiq Huq et al.

Anonymous Referee #2

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This paper describes a methodology for utilizing a nested mesh with refined vertical grid spacing within the surface layer of the atmospheric boundary layer, to provide improved fidelity of boundary-layer flow simulation at a reduced computational cost, relative to utilizing fine vertical resolution throughout the entire domain. The paper carefully describes the numerical procedure for integrating the nested domain, including thorough discussions of boundary conditions (interpolation/anterpolation) and computational efficiency. The merits of the procedure are demonstrated by comparing snapshots of vertical velocity, and vertical profiles of various mean and turbulence quantities from simulations using coarse vertical mesh spacing throughout, simulations using fine vertical mesh spacing throughout, and finally simulations using fine mesh spacing only within the nested domain overlapping the surface layer, with coarser resolution above.

Nesting is seen to significantly improve the profiles within the nested region, while also more modestly improving some features farther aloft, with a substantial computational savings of approximately factor of 7. The algorithm also shows good scaling up to about 15000 cores.

Overall I find the paper to be very well written and informative, and think it will be make a valuable contribution to the literature. I have a few recommendations to address questions I had while reading that I think will further strengthen the paper, as itemized below.

Page 11, line 5. You normalized all the profiles using scaling quantity values from SA-F only, rather than values from the respective simulations. Are there any surprises or interesting features when scaling each profile with data obtained from their respective simulations?

A general comment for all of the vertical profile figures that is relevant here is to use different line styles, in addition to the different colors, to better differentiate profiles that are nearly on top of each other. With this strategy, you should be able to plot additional data without making the plots unwieldy to decipher.

Page 11, line 9: I think it would be interesting to see the anterpolated values, just to see how the algorithm is working behind the scenes. The same comment as above regarding plotting these additional data within the same plot applies here.

Page 12, lines 5-10 & Fig. 6. Please explain more thoroughly the discontinuities in all profiles between CG and FG near the FG top. Do the plotted profiles utilize the sponge layer that you describe, or not? Perhaps you could show the results with and without the sponge layer, using different linestyles and colors, as described above.

While you show mean profiles of various quantities, it would be nice to also see if there is any impact of nesting on the structures resolved within the CG above the FG in the nested simulations, relative to the SA-C (or within the nested domain relative to SA-F, although this is not as relevant). Perhaps comparing spectra of streamwise velocity and/or w at a few heights would provide some useful information on this issue. If the nested FG in the surface layer is able to improve the instantaneous structures resolved within the CG above, that would be another noteworthy advantage of the vertical nesting capability.

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