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Interactive comment on "Mesoscale nesting interface of the PALM model system 6.0" *by* Eckhard Kadasch et al.

Anonymous Referee #2

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The manuscript "Mesoscale nesting interface of the PALM model system 6.0" by Kadasch et al. presents newly developed mesoscale nesting capabilities of the large-eddy simulation model PALM within the COSMO mesoscale model. The preprocessor INIFOR is developed to provide proper initial and lateral boundaries conditions, accounting for the differences between model variables and coordinate systems. A synthetic turbulence generator is also implemented to accelerate the transition between mesoscale and turbulence-resolving LES-scale. A semi-idealized test case of a diurnally varying dry boundary layer is presented, mostly to demonstrate the effectiveness of the synthetic turbulence generator. I applaud the authors' efforts as this could greatly expand the usefulness of the PALM model especially for real cases. The manuscript is well written, with details of the model clearly presented, and rationales thoroughly

explained. I am not sure if GMD has a word limit, but given the nature of a journal article, the authors might consider consolidating the manuscript. Overall, I suggest minor revisions.

Major comments:

1. In a nested model setup, a sponge zone or a damping layer is commonly adopted at the lateral boundaries of the nest, such that spurious wave reflections due to changes in grid resolution across the nest interface are absorbed. Correct me if I am wrong, but in the proposed implementation, Dirichlet boundary conditions is adopted to drive the PALM model. Would this cause numerical issues at the lateral boundaries, especially the outflow boundary? It would be hard to observe spurious reflections at the lateral boundaries under convective conditions, it would be much easier to spot numerical waves under nighttime stable conditions. Also, could the absence of a sponge layer at least partially explain the "rim" of time-averaged vertical motions along the lateral boundaries presented in Fig. 19? If implementation of a sponge zone is out of the scope for the current model, the authors should at least provide some justification for using Dirichlet lateral boundary conditions.

2. Does COSMO have LES capability? If so, is the LES closure in the COSMO model the same as that in the PALM model? If the answer is also yes, I would suggest the authors try the following experiment, to help diagnose some of the issues such as the mismatch of potential temperature profiles and wind profiles. The authors could set up a similar LES domain within the COSMO model, and run the same test case within COSMO. (I assume COSMO has one-way nesting capability). The differences due to the model coordinate systems should not matter too much given the limited horizontal extent of the LES domain. Then the authors could compare the nested COSMO results with the nested PALM results to understand, for example, the influence of different land-surface schemes on the vertical wind and temperature profiles in the nested domain.

Minor comments:

1. Page 3, Lines 25-26, I have to disagree with this statement. Both the synthetic turbulence method and the cell perturbation method add “artificial” perturbations to the flow that are not strictly consistent with the “physics of turbulence production”. Also, I believe the cell-perturbation method is also capable of allowing turbulence to “freely develop depending on the mean-gradients of potential temperature and wind speed”. I would like to hear your explanation but I don’t think one method has an advantage over the other in terms of physics.

2. Page 5, please combine the first paragraph with the last single-sentence paragraph on Page 4.

3. Page 5, line 5, “Both nesting features may, however, may be . . .”, please fix the grammar.

4. Page 7, line 10, better “do not generally” than “do generally not”.

5. Page 7, lines 9-17, so the divergence is removed at the LES domain level, rather than at each grid point, is that right? Perhaps point this out explicitly.

6. Page 18, perhaps the authors will explain later, but how is Eq. 17 implemented near boundaries, where points outside the computational domain are required in the double summation?

7. Page 19, lines 14-15, is there a reason why “at opposite boundaries (west and east, as well as north and south) we use the same Ψi” ?

8. Page 19, lines 22-23, correct me if I am wrong, but 2d domain decomposition means that the domain is split in the x and y directions, right? So why would this enable Eq. 27 to be computed locally, so that “no global communication is necessary”. For example, on the west boundary, the summation still requires information across processors in the y-direction, right?

9. Page20, lines 24-25, so these parameterized Reynolds stresses apply only to unstable conditions? What about stable and/or neutral conditions? Did you drop the MO

term?

10. Page 21, correct me if I am wrong, but zi is obtained by horizontal averaging along the “boundary grid point”, but u* is obtained by horizontal averaging “within the model domain”, why the difference?

11. Page 22, Eq. 37, the turbulent time scale appears to be a dimensionless number, how is it transformed into actual time?

12. Page 24, Line 12, “indicate” rather than “indicates”.

13. Page 24, Line 25, “subsequently” rather than “in the subsequent”,

14. Page 26, Line 7, you meant “RES”?

15. Page 26, Line 18, how do you set the prescribed values of H0 and LE0 ?

16. Page 32, Line 13, I would intuitively expect a monotonic increase of resolved TKE from the coarse grid to the fine grid, approaching some asymptotic values inside the LES domain. But why the TKE peak?

17. Page 40, Lines 5-8, this are most likely compensating vertical motions due to horizontally divergent and convergent flow at the inflow and outflow boundaries, as a result of continuity. I would not over-interpret this like “horizontal momentum needs to be transported downward forcing the flow to descend”.

18. Page 41, Fig. 20, please double check the legends, both “distributed” and “absolute” are marked with solid black lines.

19. Page 41, line 2, “is” rather than “means”.

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