Review of "Introduction of a Trans-scale Numerical Simulation Framework Focusing on Urban Boundary Layer: WOCSS V1.0" by Li et al. (Egusphere-2023-482)

The manuscript by Li et al. presents the WRF-OpenFOAM Coupled Simulation System (WOCSS) V1.0, which enables one-way nesting from WRF onto a Computational Fluid Dynamics (CFD) model embedded in OpenFOAM incorporated with the PreCICE library. Development of the interfaces between mesoscale and microscale models is a popular and interesting topic with advances in computation resources and the needs of high-resolution numerical simulations. The tool and results presented by the authors are interesting and the manuscript does have its own research value. However, the manuscript lacks detailed explanation regarding the rationale to develop such tool, and the description of WOCSS is also a bit thin. In addition, more analysis on the presented case study is required to demonstrate the performance and values of the tool. The presentation of figures and tables is rather poor and needs improvement. And I would highly recommend English language editing for this manuscript as grammatical errors can be spotted throughout the manuscript, which are quite distracting. Therefore, I would recommend that this manuscript should not be accepted in its current form and a major revision is required. My detailed comments are listed below.

Major concerns:

1. The rationale of the WOCSS development was not clear. There are a large number of existing studies that used WRF-OpenFOAM coupling, for example, Temel et al. (2018), Li et al. (2019), and Safaei Pirooz et al. (2021). However, not much literature review regarding such application was provided in the manuscript. I'm aware that OpenFOAM has various models and features while the authors did not state why this study is novel compared to the existing WRF-OpenFAOM studies. What is the difference between WOCSS and the previous studies? Is there any existing tool for WRF-OpenFOAM coupling? These are not explicitly explained in the manuscript.
2. According to the description of the WOCSS framework, WOCSS seems to be an extension of PreCICE that only passes data from WRF to PreCICE and then to OpenFOAM, whereas PreCICE seems to play the major role in the coupling. Can the authors explain the significance of WOCSS development? Why WOCSS is such an important addition to PreCICE? Section 2 may need to be rearranged to highlight the significance of WOCSS.
3. **Section 3.2 Turbulence Estimation:** please provide references for the estimation of the dissipation rate. Can authors clarify why Equation 1 was chosen for the estimation? There are several different methods, for example, refer to Wang et al. (2021) and Beu and Landulfo (2022).
4. **Case study results:** only horizontal cross sections at the elevation of 51 m were presented. More analysis is required to demonstrate the difference between WRF and OpenFOAM and why the usage of WOCSS has any added value. Do the authors have observations in the simulated area? Comparison between the simulations and observations (if any) would be valuable. Also, if there is any existing tool for WRF-OpenFOAM coupling, how is WOCSS different from other tools? The presented results do not provide sufficient information to answer whether WOCSS is valuable or not.
5. **Running meso-scale and micro-scale models in parallel** – What is the advantage? The authors have mentioned several times that most of the current coupling

frameworks do not run meso- and micro-scale models in parallel. The previous studies mostly used an “offline nesting” approach that the meso-scale model finished first and the micro-scale model will take the output from meso-scale. What is the difference between the two approaches (offline vs. in parallel)? In general, a micro-scale model runs slower than a meso-scale model. So without two-way nesting, running in parallel does not seem to provide any advantage. The WOCSS framework presented here is only one-way nesting. There may potentially be values in forecasting or nowcasting at micro-scale? More explanation is required.

Detailed comments:

1. Consistency is needed in the wordings. The authors used different wordings when referred to meso-scale or micro-scale **models**, which may cause confusion while reading. For example, the authors referred NWP models as “the NWP **package**” in the beginning of the manuscript; “the Computational Fluid Dynamics (CFD) simulation **code**” in Line 46 should be “Computational Fluid Dynamics (CFD) **models**”; and the authors mentioned “a meso-scale **tool**” in Line 89, while based on the concept of the sentence, it should be “a meso-scale **model**”. I would recommend the authors to revise these wordings throughout the manuscript.
2. CFD models are usually computationally expensive. How much computation time did the case study cost? How practical it is to use CFD models for urban climate research?
3. **Line 94:** The authors indicate that the approach used in Bakhoday-Paskyabi et al. (2022) is different from those in Lin et al. (2021) and Kadasch et al. (2021) by stating “Different from such approaches”. The threes studies all used the offline nesting approach between a mesoscale model and PALM (models did not run in parallel). Can the authors clarify the difference?
4. **Line 119:** PreCICE was first mentioned here but no references were provided. Recommend adding citation of Chourdakis et al. (2023).
5. **Line 128:** the description of the joint simulation is quite wordy. The details should be presented in Section 2 rather than in Introduction. The authors should only present the key points such that the readers would understand that one-way nesting is used along with WRF, WRF-LES, and the CFD model embedded in OpenFOAM. Please also add references regarding WRF-LES.
6. **Line 145:** the authors mentioned that WOCSS is a “new framework”. What is the “old” framework and what is the novelty of this study?
7. **Figure 1:** It is unclear what is the role of WOCSS here. I understand that the flowchart is for running simulations using WOCSS but both the figure and its caption did not mention anything related to WOCSS. This figure can be interpreted as a PreCICE application rather than WOCSS. Based on the description in the main text (Lines 171 to 181), WOCSS passes information from WRF to PreCICE. The resolution of the figure is quite coarse. A better image quality is required.
8. **Line 196:** please specify the variables and don’t say “the author simply modified the official adaptor”. Details are needed for readers to understand the significance regarding the development of WOCSS.
9. **Figure 2:** consider replotting and the figure caption needs rephrasing. In the figure caption, please mention the subplot labels, namely which panels are for wind velocity and which ones are for TKE. Please add dimension references (x, y, and z) in each panel. Also, the units of plotted variables are missing. Please use figures with better image quality. The figures look like combination of screenshots as the background colours are not uniform, e.g., Figures 2b and 2d look like combination of two screenshots.
10. **Figure 3:** please provide map scales.

11. **Figure 4:** please provide map scales. In the figure caption, please clarify that the blocks in light green are buildings included in the case study. The buildings are not easily distinguishable from the background maps. Recommend using a more recognisable colour.
12. **Table 1:** please add references for the schemes used in WRF simulations.
13. **Line 340:** it would be interesting to outline the grid spacing of WRF simulation domains and the grid spacing or details of the mesh setup in the OpenFOAM simulation. In addition, how did WOCSS interpolate WRF grid onto OpenFOAM grid?
14. **Figure 5:** please provide map scales. Please add figure label descriptions in the figure caption.
15. **Table 2:** please add references for the schemes used.
16. **Figure 6:** Figure caption needs to specify the details of each panel. Please use figures with higher image quality. Please increase the font sizes of axes' labels as they are hard to read in the current form. Please add spatial references of dimensions on all the right-hand side panels. I would recommend using spatial references in metres in all figures rather than using latitudes and longitudes for the purpose of comparison between WRF and OpenFOAM. And in case screenshots were used in this figure, please replot all panels as one uniform figure. What do 0 s, 60 s, and 120 s mean? Clarifications are needed. Same as Figures 7 and 8.
17. **Line 353:** As I stated previously, the comparison between WRF and OpenFOAM was only presented at one vertical level of 51 m for wind velocities. What is the added value of this coupling? The authors need to provide more comparison, such as time series, vertical profiles, and/or hourly composites of winds and temperatures, to show the added value of using OpenFOAM. Do WRF and OpenFOAM results agree with each other? How much more information does OpenFOAM provide?
18. **Figure 8:** There seems to be some artefacts (a band of very high or low values) at the lateral boundaries in OpenFOAM (right hand side subplots). While this is only mentioned in the main text, the authors may want to acknowledge such fluctuations in the figure caption.
19. **Line 366:** "reliable for predicting the turbulence" – how did the authors draw such conclusions? Can the authors provide validation of the model output to prove reliability?
20. **Line 368:** "the urban canopy parameterization activated in the WRF-LES scheme successfully predicts the reduction of the turbulent kinetic energy within the building cluster." It is not surprising that a reduction of TKE is presented when the urban canopy parameterization was enabled. It is however difficult to conclude that the model results are "successful". I would recommend the authors to present comparison between WRF, WRF-LES, OpenFOAM, and observations (if any) to show the improvements and the added values of using simulations with finer scale in OpenFOAM.
21. **Line 376:** "Such a shortage indicates the direction for the development of the trans-scale simulation framework, which is the inclusion of two-way nesting." Any previous studies and references on this statement regarding two-way nesting?

Minor items:

1. All figure and table captions – please capitalise the first letter of each sentence.
2. The usage of articles (**the** and **a/an**) across the manuscript needs to be improved. The article **"the"** is used before a noun to indicate that the identity of the noun is known to the reader. For example:
   - Line 14: "CFD simulation tool is the most popular"
   - Line 20: "via the PreCICE library"
   - Line 183: "OpenFOAM is a commonly accepted software"

3. Please revise the usage of a space between the number and an abbreviated unit of measurement in the Abstract and throughout the main text. For example:
   - Line 13: 1 ~ 100 km
   - Line 15: 1 m ~ 1 km
   - Line 103: ~1 m
   - Line 131: ~10 m
   - Line 322: 30 km
   - Line 323: 80 km
   - Line 392: 1 km
4. Line 16: “v1.0” should be “V1.0”.
5. Line 17: “thanks to” may not be very formal in scientific writing.
6. Line 25: “geoscience” should be “geoscientific”.
7. Line 31: “small-sized turbines” - please specify the size. Remove “also”.
8. Line 32-34: Any references?
9. Line 35: “As for” is not a formal way to open a sentence.
10. Line 36: “at the city scale” – please specify the scale (how many meters?).
11. Line 39: “...in physics, numeric, and data assimilation” – should “numeric” be “numerics”?
12. Line 41: Please specify “city scale” and “block scale” so readers don’t have to search the references.
13. Line 41: remove “It is noted that”.
14. Line 46: “the microscale model, i.e., the Computational Fluid Dynamics (CFD)”. As far as I understand, microscale models include CFD, Large Eddy Simulation (LES) model, and other models. This may be a misuse of “i.e.,”, which should be “e.g.,” instead.
15. Line 51: Remove “actually”.
16. Line 66: What does “commonly available” mean? Either a tool is available, or it is not. Or do the authors mean “widely available”?
17. Line 69: Please specify what is “a geophysical scale”.
18. Line 70: “utilizes” should be “utilize”.
19. Line 71: Please specify “sub-building scale”.
20. Line 88: This sentence is wordy. “for coupling the meso-scale model and micro-scale model” and “for running the joint simulation” are essentially the same idea.
21. Line 115: “the mesoscale simulation results at the city scale is...” – here “is” should be “are”
22. Line 120: Please specify “the scale of city blocks”.
23. Line 138: “section 2” should be “Section 2”.
24. Line 149: Remove “in fact”. “the WOCSS simulation” should be “simulations that used WOCSS” because WOCSS is a modelling tool rather than a numerical model.
25. Line 153: Recommend rewording to “The WRF model is well-known for weather forecasting applications…”
26. Line 155-158: please add references for the sentence “The WRF model was developed by… since the 1990s”.
27. Line 258: Please specify “the coupling effects”. Mentioning of such effect seems abrupt in this section. This usually is included in case studies or discussion sections.
28. Line 275: Why “the horizontal bi-linear interpolation” was chosen for WOCSS?
29. Line 322: “resolution” should be “grid spacing”.
30. Lines 322-323: “...ERA5 dataset… in history.” Please add references such as Hersbach (2019).
31. Lines 325-335: Recommend having a separate simulation setup section for the descriptions of maps and building outlines.
32. Caption of Figure 4: please add links/references for Bing Maps.

33. Line 347: Is “8:00~9:00” local time? Why was this time chosen for the case study?
34. Line 361: What is “the mid-height of the building”? Does this mean any specific building in the simulation?
35. Line 392: Please revise the use of “Thanks to”.

References:

Beu, C.M. and Landulfo, E., 2022. Turbulence Kinetic Energy Dissipation Rate Estimate for a Low-Level Jet with Doppler Lidar Data: A Case Study. *Earth Interactions*, *26*(1), pp.112-121.

Chourdakis, G., Schneider, D., & Uekermann, B. (2023). OpenFOAM-preCICE: Coupling OpenFOAM with External Solvers for Multi-Physics Simulations. *OpenFOAM® Journal*, *3*, 1–25. https://doi.org/10.51560/ofj.v3.88

Hersbach, H., 2019. Global reanalysis: goodbye ERA-Interim, hello ERA5. *ECMWF newsletter*, *159*, p.17.

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Safaei Pirooz, A.A., Moore, S., Turner, R. and Flay, R.G., 2021. Coupling high-resolution numerical weather prediction and computational fluid dynamics: Auckland Harbour case study. *Applied Sciences*, *11*(9), p.3982.

Temel, O., Bricteux, L. and van Beeck, J., 2018. Coupled WRF-OpenFOAM study of wind flow over complex terrain. *Journal of Wind Engineering and Industrial Aerodynamics*, *174*, pp.152-169.

Wang, G., Yang, F., Wu, K., Ma, Y., Peng, C., Liu, T. and Wang, L.P., 2021. Estimation of the dissipation rate of turbulent kinetic energy: A review. *Chemical Engineering Science*, *229*, p.116133.