Point-by-point response for the comments of reviewer #1

General

In this manuscript, the author use the newest PALM model at a spatial resolution of 1 meter to simulate various radiative transfer processes within two urban canyon (ideal and real) environments. First of all, it is very well written in a comprehensive way and considers also other meteorological properties such as the variational air flow due to the changed radiation inside urban canyons. However, the usage of a not validated simulation as a reference (in this case RTM_08) is not appropriate. Here, the authors should consider an alternative word or provide similar simulations with other models for comparing (see major comment 1).

> **Response**: *The radiative transfer model (RTM) used in the case RTM_08 of the Stepwise Parameterization Method (SPM) contains all the processes considered in the RTM version 3 (Krč et al. 2021). The validation of RTM version 3 is not a topic of this paper. The detailed validation of the RTM by means of validation of surface temperature and heat fluxes is given in Resler et al. (2021) in chapters 5.1 and 5.2. So RTM_08 is considered as our best case to compare with all other RTMs in the SPM. However, we agree that using the word "reference" may be misleading for readers, so we replace it with "full RTM 3.0".*

Major comments

1) Page 9, line 27: The simulation RTM_08 can not be a reference, mainly due to (i) the PALM model is not yet validated in a sufficient extent and (ii) as shown in Resler et al. (2020), the land surface temperature under tree shades is underestimated. Hence, the LW radiation could be wrong in the RTM_08 simulation.

> **Response:** *We agree with this (see our response to the general comment above). We have incorporated your suggestion throughout the manuscript.*

2) Page 3, line 10: The authors mentioned that the manuscript does not engage with validating the RTM. This should be also mentioned in the conclusions as it is only a split-up of different processes without any comparisons to other models/observations.

Response: Yes, a*greed. We have, accordingly, mentioned this in the conclusions section.*

3) Page 7, line 27: New studies showed that the assumption of emissivity is not true https://doi.org/10.1016/j.scienta.2012.01.022 . Otherwise use a reference for this value.

Response: *Thank you for pointing this out. Actually in RTM 3.0, the reflection in the plant canopy is ignored (Krč et al. 2021), consequently and based on Kirchhoff's law, the emissivity of leaves is set to 1. We now emphasize this point in the revised manuscript in Page 8, lines 4-5.*

4) Page 8, line 9: Could you please specify in the text, what is meant by "only ONE SINGLE reflection"? Is it referred to one single reflection of the whole area or to the iteration?

Response: *"only one single reflection" means one iteration of the reflection process. In other words, each surface is allowed to reflect and receive reflected radiation from one iteration only of the in reality infinite number of reflections. This means that the reflection of the reflected radiation is not considered. We specify this in the revised manuscript at page 8 line 16.*

5) Page 8, line 19: What is the reason behind this (four iterative reflection)? Please justify your decision or include a reference that shows the decreased importance of higher ordered multiple reflections.

Response: *The number of iterative reflections (four iterations) is chosen based on the convergence's criteria of multiple reflections in RTM. This includes the mean net radiant flux error, the quantile of the net flux error, and the mean unreflected radiant flux. That is to assure that the absorbed radiation at the last reflection step is small enough so that any further reflections can be ignored. Based on the RTM evaluation reported in Krč et al. (2021), this criteria is satisfied after 3 iterations. We added this reasoning to the revised manuscript at page 8, lines 27-28.*

6) Page 8, line 27: Section 3.1, please give additional information regarding the pavement characteristics in this configuration. In the results (4.1.2), the effect of pavement is highlighted, however it is not clear, if all surfaces between the buildings (incl. under the trees) are paved or not.

Response: *Additional details about the pavement in the simple urban configuration are added to Sect. 3.1. Actually, all surfaces between buildings are paved.*

7) Page 9, line 28-29: Similarly to the "simple urban configuration" (major comment 6), do the results of the "realistic urban geometry" case refer to a defined focus domain or to the whole area (1x1 km2)?

Response: *The results of the "realistic urban geometry" case refer to a defined focus domain so that the boundary bias is eliminated.*

8) Page 11, line 15-16: How would the authors explain the results for 3b RTM_04?

> **Response:** *The incoming LW radiation for the idealized urban configuration is low because the water vapor is set to resemble a dry area. However, based on the comment from reviewer 2, we have redone the simulations using a typical mid latitude summer day.*

9) Page 15, line 24: The effect of vegetation is in accordance with the vegetated area based on the satellite image, however based on Fig. 2. it seems that only a limited amount of plant canopy boxes were considered in the simulations. Did the authors make additional assumptions regarding vegetated areas in the realistic urban configuration?

> **Response:** *No additional assumptions are made on the vegetated areas. We corrected the rendering of the photo to account for the vegetated areas in the realistic urban configuration.*

10) Page 17, line 25: In Fig. 26, how would the authors explain the results of 26c (potential temperature) in case of RTM_01?

> **Response:** *In RTM_01, the horizontal surfaces receive SW and LW radiation (from sky), but vertical surfaces do not. Especially in daylight, the heating of these surfaces is underestimated. However, the parameterization of RTM_01 is changed, based on comments from Reviewer 2, so that all surfaces receive an average value of SW and LW radiation. This behavior has changed accordingly. Moreover, we used box plots to better visualize error measures.*

11) Page 20, line 1: The authors point out that their aim was to evaluate the performance of PALM/PALM-4U simulations using different radiation transfer processes. In the first funding phase of MOSAIK, a measurement campaing was completed in order to evaluate the model results based on measurements. I would suggest to refer to these ongoing activities in Section 4.5.

> **Response:** *Thank you for this suggestion. We have, accordingly, referred to the measurement campaign performed in the first funding phase of MOSAIK along with the measuring campaign done in Resler et al. 2021; in Section 4.5.*

12) Page 20, line 20-23: The statements have to be seen in relative terms as RTM_08 was considered as a reference for the comparison in the study. If possible, cite other studies with similar RTM methods and compare them.

> **Response:** *We agree here. We have reformulated the statements so that the three RTM categories are seen relative to RTM_08. We also referred to those*

studies which showed the effect of solar radiation on the flow mentioned in the Introduction section.

Minor comments

Page 1, line 6: Typo - twice "the"

Response: *Agree. Fixed in the revised manuscript.*

Page 2, line 2: Insert some citations

Response: *Agree. Additional citations are added to the revised manuscript.*

Page 3, line 19: Please highlight that there are ongoing PALM-4U urban-related developments (e.g. physical implementations, evaluating the interaction of different modules and the practicability) in the framework of the second funding phase of MOSAIK.

Response: *This is indeed a good hint. The ongoing PALM-4U developments are added to the revised manuscript; page 3, line 27-28.*

Page 3, line 26: Abbreviation SGS necessary if only used once?

Response: We *agree. The abbreviation is removed from the revised manuscript.*

Page 6, line 1: Captions (here Table 1) should be written as a stand-alone text. So please describe all abbreviations.

Response: We *agree. Caption is revised to be stand-alone text.*

Page 6, line 11: Do you mean "each grid cell" instead of "each surface"? It variates within a surface.

Response: *Actually we mean each surface (grid-cell side) since SVFs are calculated on the surface base, rather than a grid-cell base. We added this explanation to the revised manuscript (page 7, line 2).*

Page 8, line 17: See major comment 3 with emissivity of leafs.

Response: *We agree. Please see our response to the major comment No. 3.*

Page 11, line 13: Fig. 3a, please use a dashed line as last to see other colors immediately OR give a note in the caption of the figure.

Response: *A note is added to the caption to explain the overlap of these lines.*

Page 12, line 16: Please consider the comment above regarding pavement surfaces (major comment 6).

Response: *We agree. The pavement surfaces are considered in the analysis. However, since the previous RTM step has been changed, based on the recommendation of Reviewer 2, the discussion of this part has been changed accordingly.*

Page 13, line 9: Typo - it is Fig. 9a.

Response: *We agree and changed accordingly.*

Page 14, line 14-15: Descriptions should be in section 2, not in results.

Response: *We agree. Those descriptions are removed from the result section and moved to Sect. 2.*

Page 14, line 21: Typo - Fig. 3b

Response: *Agreed and fixed accordingly.*

Page 17, line 31-32: Please highlight, that the results were compared to RTM_08.

Response: *We agree. We highlighted that comparisons are made against RTM_08.*

Page 20, line 5: The PALM/PALM-4U model system is under development, new revisions are made available very frequently. In order to follow further developments, I would suggest the authors to include the revision number of the model version used in this study.

Response: *We agree. The respective revision number is added in the revised manuscript on page 22, lines 7-8. It is worth mentioning here that currently the SVN revision is replaced by the PALM release scheme.*

Page 28, Fig 1: An additional north arrow would make the orientation in the focus domain easier.

Response: *We agree. The north arrow is added to the domain in Fig. 1.*

Page 29, Fig 2: If you use Google maps pictures, the Google copyright sign needs to be inside the picture too!

Response: *We agree and added the copyright sign of Google to the maps.*

Page 31, Fig 4: Typo - blue is referred to LW.

Response: *Agreed and fixed.*

Page 33, Fig 6: Unit is missing. See also other similar plots with buildings (Figs. 8, 10, 12, 14, 16, 18).

Response: *We agree. Units are added to the respective figures.*

Page 33, Fig 6: Rectangles in the corners are the roofs, isn't it?

Response: *Exactly. We added this information in Figure 6.*

Page 38, Fig 11: Typo - LW in Fig. 11b

Response: *Agreed and fixed.*

Page 50, Fig 23: Please make sure that 0 W/m2 is white and not gray. Maybe you can mask buildings to see urban canyons better. See also Google maps comment!

Response: *Thank you for this suggestion. However, Fig. 23 is removed to reduce the number of figures, based on the recommendation of Reviewer 2.*