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Geoscientific Model Development
Discussions

Interactive comment on "Importance of radiative transfer processes in urban climate models: A study based on the PALM model system 6.0" *by* Mohamed H. Salim et al.

Anonymous Referee #2

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This study investigates the differences between radiative flux density received by urban surfaces and meteorological parameters (wind and potential temperature profiles) for different degrees of complexity of the radiation modelling in the building resolving urban climate model PALM 6.0. The analysis is made for clear-sky summertime conditions and one idealised and a real urban configuration (a 1 km x 1 km domain located in Berlin, Germany). The results indicate that a relatively high degree of complexity of the radiation modelling is required, considering the sky-view factors of individual facets, the view factors between different facets, urban vegetation, and at least one reflection. Only the interaction of vegetation with reflected radiation and/or the multiple reflections might be omitted without generating too large errors in the relevant prognostic variables.

This study deals with an important topic and is conducted using the cutting-edge urban climate model PALM. The study is conducted with rigour, and the methodology and presentation of the results are generally clear. There are however, some potential issues that need to be resolved before the study can be published. I therefore recommend publication after major revisions have been made.

Major review points:

- The downwelling longwave flux density of $\sim$150 W/m^2 (sky temperature $\sim$220 K) for the idealised urban configuration is suspiciously low and seems unrealistic for a summer day. It is also in noted contrast with the value for the realistic urban configuration, which looks much more plausible. I suspect that water vapour content has been set to 0.0 for the idealised configuration (?). Although such low LW values might be possible on a summer day, e.g. in a very dry area, I consider that they are too far from typical values to be used. The choice of the value for the downwelling longwave radiation will change the results of the study, since for example the effect of the tree absorption depends on the difference between the effective sky temperature and the leave temperature. I therefore propose to redo the simulations using a typical mid latitude summer daily cycle of downwelling longwave radiation.

- For the comparison of the different Radiative Transfer Models (RTMs), the meteorological parameters are also allowed to vary. This introduces a feedback since the longwave radiation depends on the surface and air temperature. It would be more rigourous to make a pure comparison of the RTMs, keeping the flow (wind and temperature) completely identical. This analysis should be followed by a second set of coupled simulations, allowing to investigate the changes of the meteorological conditions in the urban canopy layer for the different RTMs.

- There are some restrictions based on the choice of the urban configuration and parameters that should also be named: 1) the building height is homogenous in the simple urban configuration, therefore the differences of radiation incident on the roofs are zero. 2) the albedo of 0.1 is quite low, the effect of neglecting SW (multiple) reflections might be higher for other cases. 3) Trees are lower than buildings, thus potentially underestimating the vegetation effect.

- An alternative to RTM_01 could be to partition the incoming radiation in an equal manner between all the urban surfaces. E.g. all surfaces (horizontal and vertical) reveive the downwelling SW flux density divided by the total urban surface divided the horizontal urban surface. This would be as computationally cheap as RTM_01, and maybe deliver better results.

- Concerning the flow conditions, it seems from Fig. 24 that there is no turbulence except the one that is produced due to the presence of the obstacles (e.g. e is close to 0.0 above the buildings in the neutral case). This is not very realistic and might influence the conclusions from the study. Furthermore, the information on how the reference values of velocity and temperature are calculated seems to be missing.

- The violin plot figures could become much more informative if the difference surfaces (ground, walls, roofs) would be distinguished by different colors or symbols.

- There is an excessive number of figures. Some could be omitted, since they show only very small differences. E.g. 7b, 9a, 11a, 15, 16. Other figures might be regrouped.

- The titles of the figures (e.g. "(a) Changes in SW radiation flux") should be above the respective figures.

- The wording "irradiance" and "radiative flux density" is used alternately. Is this on purpose? Otherwise, if always the same physical quantity is meant, it should be homogenised.

- There is a mix between British and American English.

Minor review points:

- Page 1, L6: "the the PALM model".

- Page 1, L7-L10: this is a mix between methodology and results. It might be better to separate them.

- Page 1, L13-14: here the processes that need to be considered / could be neglected should be named explicitly.

- Page 1, L16: "urban environment".

- Page 2, L6: unclear what is "large configurations".

- Page 3, L2: within an urban area.

- Page 4, L25: what means "in the vicinity of vegetation"? Should it not be "in the presence of vegetation"?

- Page 4, L27: "infinite reflections".

- Page 5, L4: "the diffuse downwelling SW and LW fluxes" (?)

- Page 6, Table 1: - Unclear what is meant by "receiving radiation from surface emission". - Single reflection: is it SW and/or LW? - Multiple reflections: is it SW and/or LW?

- Page 6, L7: "vertical surface reveive no radiation". For SW, this is clear, but for LW it should rather be stated that the net LW radiation is assumed to be 0.0 W/m^2.

- Page 7, L2: "subprocess" -> "RTM"?

- Page 7, L7: "transferred to air": how is it partioned between sensible and latent heat flux?

- Page 7, L13: maybe shift "additionally to the SVFs" to be beginning of the sentence.

- Page 8, L16: "Fortunately". Dont use such emotional expressions.

- Page 8, L20: vegetation partially absorbs.

- Page 9, L5: 24 trees in total.

- Page 9, L6: Lalic et al. (2013).

- Page 9, Eq. 3: division by zero if z=h.

- Page 11, L4: "to initialize".

- Page 11, L5: to reduce the computational load.

- Page 13, L5: is it not the difference of the received radiation?

- Page 14, L3: all surfaces receive radiation.

- Page 14, L30: the surfaces.

- Page 14, L30: especially roof surfaces receive no ... .

- Page 15, L1: receive less LW.

- Page 15, L5: reflected radiation (?)

- Page 15, L17: change more in the realistic case ...

- Page 15, L19: secondly (?)

- Page 15, L19: higher than for the ...

- Page 15, L26: thirdly (?)

- Page 16, L31: in fact the wall heating should be more pronounced during the early morning and late afternoon that at 12:00, leading to potentially larger differences in the flow field at these times.

- Page 17, L8: the second group includes.

- Page 17, L29: are of good quality.

- Page 17, L30: both urban configurations.

- Page 17, L31: in the daytime.

- Page 18, L9: compared to those.

- Page 18, L11: based on the above discussion.

- Page 18, L13: Maybe more precise: within the urban canopy layer.

- Page 18, L20: to include.

- Page 21, L2: the results show.

- Figure 4: must it not be "the LW irradiance is blue"?

- Figure 10: are folded the same way.

- Figure 27: "wind wind speed".

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