Response to the Referee

We thank the Referee for the insightful and constructive comments on our manuscript. The format is as follows:

> *Referee's comment*
> Our reply (revised text)

Referee #2

Review of the manuscript entitled "A new Earth Observation-based WRF configuration for urban regional climate simulations over Paris" by Kyriakidis et al.

This manuscript evaluates the performance of the WRF-urban modeling system over Paris during a three-month (JJA) warm summertime period. Three WRF-experiments are conducted over the metropolitan area, one simulation using the BULK scheme to represent the urban surfaces, and two simulations (i.e., CTRL and PAR) using the multilayer BEP-BEM urban canopy model. In the CTRL run, urban pixels were classified using the LCZ classification system, but the urban canopy parameters (UCP) for each LCZ were not modified (default values). On the other hand, in the PAR simulation, the UCP were tailored for each LCZ using morphological observations across the metropolitan area. WRF-simulations were compared against urban and rural weather stations for near-surface air temperature across the diurnal cycle. Numerical results demonstrate that the CTRL and PAR runs outperform the BULK simulation, but it was not clear which BEP-BEM simulation produced the best results. It seems like the PAR run performs better than the CTRL run in rural areas, but not in urban areas leading to a better (worse) representation of the nocturnal (diurnal) UHI. This topic is interesting and worthy of being investigated, but some minor clarifications are still needed before this manuscript can be accepted for publication.

We thank the Referee for the feedback. The manuscript has been revised and we have corrected typos, such as the table numbering (two Table 3 were named in the previous version of the manuscript) and Referee's second comment regarding the nighttime interval.

Following are my comments:

1. Table 3. Why were the urban fraction changes not included in this table?

Thank you for your comment. This has been previously answered in our responses to the comments of Referee #1 before the final response process. We have found that, ultimately, regarding the urban fraction for the two BEP-BEM simulations (PAR and CTRL), urban fraction values were not taken into account from the lookup table URBPARM_LCZ.TBL but from the wrfinputs. As a result, both experiments had the same gridded urban fraction values (not per LCZ class) through the WUDAPT to WRF (W2W) process (Demuzere, M., Argüeso, D., Zonato, A., and Kittner, J.: W2W: A Python package that injects WUDAPT's Local Climate Zone information in WRF, J.

Open Source Softw., 7, 4432, https://doi.org/10.21105/joss.04432, 2022). This process has been utilized in the framework of FPS URB-RCC for the creation of the geo_em files. Consuquently, the urban fraction changes were not included in Table 3 neither the database used for this variable in Table 2. Thus, in manuscript version 2 we have clarified that issue by adding the following sentence to section 2.3 (lines 242-243):

"PAR and CTRL shared the same values for the rest of the UCPs and urban fraction was defined on each grid cell by the W2W process."

2. Line 283. Is the nighttime interval from 18:00 to 07:00 UTC or from 18:00 to 05:00 UTC?

Thank you for noticing this typing error, which has been corrected. The nighttime interval is indeed from 18:00 to 05:00 UTC.

3. Lines 285-286. "Therefore, in terms of overall model error (RMSE) the CTRL simulation performs better during the daytime, while the PAR configuration performs better during nighttime". However, Table 3 shows that the CTRL simulation performs better than the PAR simulation during the daytime and nighttime for urban areas.

We thank the Referee for pointing this out. This statement is indeed incorrect, and we have modified the sentence as follows:

"Therefore, in terms of overall model error (RMSE) the CTRL simulation performs better during both daytime and nighttime."

Additionally, the numbering of Table 3 has been corrected to Table 4, and the numbering of all subsequent tables, as well as their corresponding references inside the manuscript text.

4. Section 3.2. Table 5 and Table 6 show again that the CTRL simulation performs better than the PAR simulation for urban areas.

Thank you for your comment. CTRL performs better than PAR in terms of RMSE during the heatwave as noticed in Tables 6 and 7 (previously Tables 5 and 6). Neither comment has been previously made regarding this issue in the older manuscript versions nor has it been implied that PAR is performing better than CTRL during this period. Indeed, in section 4 (Summary and Conclusions) we have already mentioned that (lines 493-495):

"During the heatwave event of August 2020 in Paris the warm biases become more severe. Implementation of the Paris–tailored UCPs in WRF results in even higher warm biases over all LCZs."

We have modified the abovementioned statement as follows, to also point out the worse performance of PAR in terms of RMSE too:

"During the heatwave event of August 2020 in Paris the warm biases become more severe. Implementation of the Paris–tailored UCPs in WRF results in even higher warm biases and RMSE values over all LCZs and urban stations, when compared to CTRL."

5. Line 556-557. "Following the WRF default configuration, anthropogenic urban heat emissions were assumed to be constant over 24 hours, an assumption that likely overestimates actual conditions". However, unless specified otherwise, BEP-BEM computes the AH emissions (from the AC systems) based on the target indoor temperature, Coefficient of Performance of the AC systems, and outdoor environmental conditions, it is never a constant value. Please, clarify.

Thank you for pointing this out, since it lacks clarification. Our intention by mentioning "anthropogenic urban heat emissions were assumed to be constant over 24 hours" was to highlight the fact that A/C systems were functioning during the whole 24-hour span. The working hours of A/C systems can be modified for each LCZ class through these parameters inside URBPARM_LCZ.TBL:

1) TIME_ON: Initial local time of A/C systems, [h]

2) TIME_OFF: End local time of A/C systems, [h]

We kept the default values for these two parameters across all LCZ classes (TIME_ON=0, TIME_OFF=24), an assumption we think may contribute to an overestimation of anthropogenic heat emissions through the A/C systems.

Apart from these two parameters, both Coefficient of Performance of the A/C systems and the Target Indoor temperature (namely COP and TARGTEMP, respectively) define anthropogenic heat emissions. These two parameters had also the default values in URBPARM_LCZ.TBL, as noted in the following sentence in section 2.2.2 (lines 191-193):

"Additionally, UCPs related to anthropogenic urban heat emissions remained unchanged from the default values WRF provides and were assumed to be constant over 24 hours."

Following a review of the abovementioned sentence, we decided that this also needs further clarification and it has been modified as follows:

"Additionally, UCPs related to anthropogenic urban heat emissions remained unchanged from the default values WRF provides and air–conditioning systems were assumed to continuously operate over 24 hours."

All these four parameters interact with environmental outdoor conditions and, since these were not the same in the two BEP-BEM runs, anthropogenic heat emissions might differ in the two simulations. To sum up, our initial intention was to mention the fact that A/C working hours remained by default across the 24-hour span.

As a result, we modified in Summary and Conclusions the statement you have mentioned and its following sentence ("This simplification may contribute to the overproduction of urban heat in the present simulations.") as follows:

"The WRF default configuration assumes a continuous 24–hour operation of air–conditioning systems for all LCZ classes, which may further contribute to the overproduction of urban heat in the present simulations."

We again thank the Referee for their thorough comments and evaluation. We believe that the revisions have enhanced the consistency of the manuscript.