Review for Manuscript GMD Manuscript entitled:
Assessment of the Paris urban heat island in ERA5 and offline SURFEX-TEB (v8.1) simulations using METEOSAT land surface temperature product

Summary:

The authors use offline urban climate simulations and ERA-5 reanalysis data to demonstrate that the ERA-5 dataset does not accurately represent the spatial pattern of built-environment induced warming. They conduct two sets of simulations, based on the premise that "bulk urban parameterization is often employed in state-of-the-art regional climate simulations", replacing the urban landscape with a bulk "rock covers" for one set, and using the TEB UCM for the second set of simulations.

The science is reasonable, the analysis is sound, but the justification for the work done is disingenuous at best, or patently false at worst. To state that "bulk urban parameterization is often employed in state-of-the-art regional climate simulations" couldn't be further from the truth. UCM models of varied complexity are used the world over and these are detailed below.

Although critically important, because the current language considerably misconstrues the importance of the research, I do not view the required modifications to the manuscript to be major and do believe that once the language is toned down, the paper will become suitable for publication.

Specific comments

Abstract: However, most of the state-of-the-art global and regional climate models have an oversimplified representation of (or completely neglect) urban climate processes.
Comment: This is certainly not the case for "most regional climate models" and details are provided below. This cannot be used as a justification for the work provided since "most" RCMs and urban climate modeling researchers have been using a varied complexity of single or multi-layer urban canopy models for the last 1-2 decades!

Abstract: Finally, the offline SURFEX-TEB framework applied here demonstrates the ability to simulate the urban climate, which is an asset to build urban climate projections that allow the development of mitigation and adaptation strategies.
Comment: improved characterization of urban climate change requires coupled simulation, rather than offline simulation where the built environment is forced by the overlying atmosphere but does not have a chance to interact with it. If the objective is to "build urban climate projections that allow the development of mitigation and adaptation strategies" it becomes difficult to justify why offline simulations are the way to go.

Line 70: Moreover, while observations cover the past, numerical simulations can be extended to the future and, therefore, consider different scenarios of future socio-economic evolution, urban development, and adaptation strategies.
Comment: Indeed, this is an excellent point and requires supporting references since such work is now increasingly performed. For example, the very first large-scale effort to conduct such mesoscale (process-based) coupled (urban UCM to the overlying atmosphere) simulations, accounting for both urban expansion and greenhouse gas induced climate change (i.e., socioeconomic evolution), allowing for a direct comparison among the urban environment forcing agents, including adaptation strategies that may offset this warming, should provide context for the readership and should be acknowledged:
Georgescu, M., Morefield, P. E., Bierwagen, B. G., & Weaver, C. P. (2014). Urban adaptation can roll back warming of emerging megapolitan regions. Proceedings of the National Academy of Sciences, 111(8), 2909-2914

Line 72: Most state-of-the-art climate models do not consider or have simplified representations of the urban environments (Garuma, 2018; Zhao et al., 2021).
Comment: It is at this point that the language begins to require a toning down, as it completely misrepresents the state-of-the-science.

For example, many RCMs today (and for the last decade or two) widely use various versions of a single layer urban canopy model that accounts for the building geometry of cities, shadowing from buildings, and even anthropogenic heating (e.g., Kusaka et al., 2001):
Kusaka H, Kondo H, Kikegawa Y and Kimura F 2001 A simple single-layer urban canopy model for atmospheric models: comparison with multi-layer and slab models Bound.-Layer Meteorol. 101 329–58.

In addition, more complex models (multi-layer) are increasingly being used in such process-based models. The wording here (and elsewhere) needs to be modified as it is not an accurate reflection of the state-of-the-science (in the Abstract as well and other locations as needed).

Line 82: However, the use of UCM coupled to RCMs is not a standard procedure for climate simulation (and is not projected to be in the next generation of multi-model RCM ensembles) due to its very high computational costs, resulting in a poor representation of many aspects of urban climate in state-of-the-art RCM ensemble datasets
Comment: Again, RCMs coupled with UCMs have been used in climate mode. While this is not "standard", the statement is misleading since it omits the realization of such simulations (e.g., Krayenhoff et al., 2018, which was actually referenced in this manuscript).

Line 91: Despite those limitations, recent studies have demonstrated the added value of this approach in reproducing key features of observed urban climate compared to traditional climate simulations (without representation of urban processes), including the UHI and the frequency, intensity and duration of urban extreme temperature events (Broadbent et al., 2018; …)
Comment: Neglecting advective processes within the urban climate modeling domain is a major shortcoming. The "added value" referred to by the authors is simply a reference to reduced computational limitations, but nothing more. The question then becomes "What is the value lost" when using this simplified approach? To my knowledge, this question has not been addressed. Again, the justification for the performed work relies on an assessment of the science that is roughly 2 decades old.

Line 97: … demonstrated how this type of framework may be used to disentangle the impact of land-use change, from large-scale warming induced by greenhouse gas emissions, and from natural climate variability.
Comment: Again, this has been done using traditional dynamical downscaling for climate simulations (decadal length simulations) - I feel it is a little disingenuous to omit this work since considerable research in this area to "disentangle the impact of land-use change from large-scale warming induced by greenhouse gas emissions" has already been performed (e.g., Georgescu et al., 2014; Krayenhoff et al, 2018; Broadbent et al.; 2020). The issue of "natural climate variability is certainly an additional distinction and that requires simulations on the order of many decades or longer (e.g., AMO or PDO cycles):
Broadbent, A. M., Krayenhoff, E. S., & Georgescu, M. (2020). The motley drivers of heat and cold exposure in 21st century US cities. Proceedings of the National Academy of Sciences, 117(35), 21108-21117

Line 145: “last-generation”
Comment: Change to “latest-generation”.

Line 173: This bulk urban parameterization is often employed in state-of-the-art regional climate simulations.
Comment: This is oce again patently false, as detailed with the already specified references, and should be removed. Many scientists are now using multi-layer schemes, and some are even using building energy models coupled to the multi-layer scheme (e.g., see several of Francisco Salamanca's papers and please perform a thorough read of Fei Chen’s 2011 Int. J. Clim. paper that goes deep into the issue of varied urban parameterizations beyond the bulk scheme, many of which, as already mentioned and referenced in my comments, have been used for 1-2 decades):
Salamanca, F., Krpo, A., Martilli, A., & Clappier, A. (2010). A new building energy model coupled with an urban canopy parameterization for urban climate simulations—part I. formulation, verification, and sensitivity analysis of the model. *Theoretical and applied climatology*, *99*(3), 331-344

Salamanca et al 2011 compared WRF performance using a bulk scheme to more advanced urban representations more than 1 decade ago:

Salamanca, F., Martilli, A., Tewari, M., & Chen, F. (2011). A study of the urban boundary layer using different urban parameterizations and high-resolution urban canopy parameters with WRF. *Journal of Applied Meteorology and Climatology*, *50*(5), 1107-1128