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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Modelling spatiotemporal variations of the canopy layer urban heat island in Beijing at the neighbourhood-scale" *by* Michael Biggart et al.

Anonymous Referee #2

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General Comments

The paper entitled "Modelling spatiotemporal variations of the canopy layer urban heat island in Beijing at the neighbourhood-scale" uses the ADMS-Urban climate model to depict the influence of the Beijing metropolitan area on the climate. Although this paper could be of substantial added value for the community, in particular by highlighting the strength of the ADMS-Urban model in comparison to other models, or also by deeply studying the biases during heat wave conditions, the paper sticks to a rather descriptive tone that does not seem to answer any research question. I have serious concerns about some methodological aspects that are given below as major comments. In par-

ticular the drawing of some conclusions based on one satellite image only cannot be considered as a strong evidence to sustain some arguments given by the authors. I would recommend improving the introduction to define the key research questions that will be answered in the paper. The methodological section will also need to be reworked to be more easily understood. In the results, there are numerous parts that could be implemented in the discussion part, depending on the research questions to be answered. Finally, I would like the authors to clearly enumerate the key outcomes of their research in the conclusions, their limitations, and potential guidelines to continue their effort.

Major Comments

- Lines 70 - 79: Could you add something about the temporal coverage of satellites? Afterall, most of them only take snapshots of the SUHII and this further limits their use to understand when people may be at higher risks during the day.

- Lines 103 - 104: There are many other works which implemented LCZ in regional climate models to study the UHI. Actually, the work from Alexander et al. (2015) used the SUEWS model that you describe as an urban energy balance model, while your model is an urban climate model. Also, I do not think that Alexander et al. (2015) used OSM for making their LCZ map. Please clarify these points here to make clearer on what your study "builds upon".

- At the end of the Introduction I am missing some key research questions which you will try to answer. Your description on the challenges related to the use of remote sensing and in-situ measurements are properly highlighted in a very clear and efficient manner as well as the use of UCMs for coping with these limitations. But I don't really get what your study will bring further. Could you add a paragraph on that before detailing the contents of the subsequent section? Also, could you explain why you chose the ADMS-Urban model in particular? This could be explained in Section 2.1 too.

- Line 127: What do you define as "upwind"? How do you get this information since it

is at the baseline of your model from what I understand. I am not really familiar with the ADMS-Urban climate model and I miss a bit how it actually integrates information at the boundaries to the inner parts of the domain.

- Lines 160 - 174: Here you say that the model is driven by rural stations. Are they at the boundary of your domain? You use only the Airport weather station to force your model from what I understand. What are the potential limitations to that for an extended city as Beijing? Did you also consider that the airport is located in a rather built up environment (when looking at your Fig.1)? Why not using the Pinggu Station instead? Also, do we have to understand that the winter and the summer domains are located at the same place based on the winter wind direction? In general I had a hard time understanding which data is used to drive the model, what is your domain extension, its horizontal resolution and why you chose those three stations among others.

Lines 191 - 195: How did you get these values of 200 and 150? What is the rationale for saying that one is representative of densely built-up LCZ and the other of more open urban typologies? Please explain.

Lines 200 - 211: This paragraph partially answers some of my previous comments but I still have a very hard time understanding what is "upwind". If it is a border surrounding a domain then it means that all winds converge to the city center? In general I think that the methodology part will need a complete restructuring.

Lines 219 - 221: Please explain how this is spatialized throughout the domain and provide the reader with an equation on the scaling from one LCZ to another.

- Section 2.5 is among my main concerns in the methodology. I somewhat understand the reasoning behind those choices but I don't think that using LST to evaluate air temperature is a good thing to do. Additionally, the use of only one Landsat 8 image for evaluating a model that is run for 2 months seems really limited to me. To that I would like to add that Landsat 8 LSTs retrieved by Jimenez and Muñoz techniques are directly correlated to the NDVI. The calculated emissivities are therefore often not

representative of the actual emissivity of the urban environment. Why not use MODIS instead? It also has its limitations but has a more recurrent overpass. Lastly, I don't think that quitting the AHE for the evaluation is justified. I grasp your concern and I support it. But to me, since we don't know how it influences the LST, it is best to keep them. After all, the model is supposed to accurately represent urban LST with human influence, no?

- Lines 271 - 274: I don't understand the Evp150 case. Why are you changing the values because of a measurement at the IAP site? You force your model with the airport AWS right? Please clarify the reasoning here.

- Lines 287 - 290: Here I still did not understand if your model simulated the temperature at the rural site ? If not, you cannot compare UHIIs. In general I would advise to do the evaluation for 2m air temperature at both the urban and the rural site and not for UHIIs. This will be more indicative of where the model is having troubles representing the local climate.

- Lines 335 - 339: I have the feeling that you put a lot of trust in your model. I agree with your arguments but it may simply be related to how the model works, no?

- Lines 367 - 368: In my humble opinion, LSTs are only indicative of places that may be correlated with higher urban heat. But other factors play an important role and this is why I would be really cautious with the interpretations that come from one satellite image only.

- Section 3.2: Following the previous comment I would recommend to entirely rework this section. You draw a lot of conclusions on one satellite image only and you tend to expect a high level of correlation between the urban LST at 11 AM and the modelled air temperature. You would need to demonstrate this correlation with AWS observations in my opinion. Other possibility may be to use more satellite images to try to show the recurrent correlations. Otherwise, I would suggest to remove this part.

- Section 3.3: I don't see the added value of this section. Do we really learn something about the heterogeneity of the urban climate in Beijing here? Why did you focus specifically to the surroundings of the airport? You have an LCZ map. Why don't you compare the temperature distributions between LCZs for example?

- I really liked reading the section 3.4. It is highly indicative of potential deficiencies in the modelled climate during a heat wave events. That is, I believe, a strong part of the manuscript as heatwaves are of key interest for public health.

- Lines 485 - 489: Again, are you sure that AHE are the only explaining factor?

- Lines 512 - 517: Does this manuscript really support this argument? In the end, I felt that the manuscript was rather descriptive and did not have a general story line. I would recommend suppressing these lines as you do not test what urban planning solution may be more appropriate or not.

- Please revise all your figures and their captions so that they are easily understood by readers as stand-alone pieces. In particular, avoid using acronyms or explain them in the caption.

Minor Comments

- Lines 49 - 51: This sentence should be put in the first paragraphs as it is the increasing amount of population living in cities that drives urbanization and its related land-use land-cover (LULC) changes

- Line 57 : "estimated" instead of "estimates"

- Lines 66 - 69: Could you comment upon that result and their methodology ? In general, shouldn't we use multiple rural and urban sites to quantify the UHII? I know you introduce the concept just above but try to make it clearer why dense urban, suburban and rural meteorological stations' networks are required.

- Line 70: Add "surface" before "temperature"

- Line 73: What do you mean by "control variables"?

- Line 79: What about the viewing angles? Would you propose a range of optimal viewing angles?

- Line 80: The link between the two paragraphs needs to be improved. Urban climate models are not introduced previously and come a bit out of the blue.

- Line 150: What is the Normalized Building volume? How is it normalized? Please provide this information to the reader.

- Lines 195 - 197: I don't understand this sentence. OSM offers albedo values?

- Lines 235 - 239: Do the AHE still contribute to the heating of the air in the model? Please clarify.

- You have two Sections 2.5.

- Line 284: Please don't call it an UHII. It is only based on two automatic weather stations. You can talk about a difference between an urban and a rural station.

- Lines 294 - 299: Could be put in the discussion instead.

- Lines 302 - 305: This discussion does not seem to have its place here. It is not a pure evaluation but rather an additional perspective on the outcome of the study. Also, local characteristics may indeed be a factor but cannot justify as a whole the observed biases.

- Lines 357 - 358: Are SW radiation the only explaining factor or could winter AHE due to heating be also the cause of such a difference?

- Lines 355 - 361: Could this part go in the discussion?

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