The Vertical City Weather Generator (VCWG v1.3.0)

Response to Reviewers

Moradi et al.

December 22, 2020

Dear Dr. Wolfgang Kurtz:

Thank you for your comments and those of the reviewers. We implemented all the outstanding minor comments in this final revision. In brief, we removed the comparison of UHI for the daily maximum and minimum case in Vancouver as requested by the reviewer #4. In addition, we carefully examined the UHI comparison between the model predictions and observations in Vancouver, Buenos Aires, Osaka, and Copenhagen. Now we carefully specify if the reported UHI values were at specific times or diurnally/monthly-averaged. We read the manuscript multiple times and checked the writing, figures, and references for accuracy. We hope you find this version satisfying the high journal standards.

Regards,

Amir A. Aliabadi

1 Topical Editor Decision: Dr. Wolfgang Kurtz

Dear authors,

Thank you very much for submitting the revised version of your manuscript. Your paper was again reviewed by two former referees and both were quite positive about the new version of your manuscript. Reviewer #4 indicated a few minor issues that should be addressed before the final publication of the paper (see corresponding referee report). These should be addressed in one further (and hopefully final) revision. Although only minor changes were indicated, I have chosen 'major revision' to potentially allow referee #4 to comment on your changes again (if necessary).

Best regards, Wolfgang Kurtz

Response: Thank you. We are in agreement with your comments and implemented all the required changes.

2 Reviewer 4

2.1 Comments

The authors have well taken into account the comments by the two reviewers of this review round. The following minor issues remain.

Response: Thank you. We have implement the comments carefully.

1. For the roughness length for temperature and humidity, you state that "a typical value" (it is rather a formulation than a value) "is often used" / "often assumed". But what do you use in the present manuscript? Probably the formulation you state, but it is not clear enough.

Response: Thank you. We edited the manuscript as follows.

A typical formulation $z_{\overline{\Theta},rur} = 0.1 z_{0rur}$ [m] is often used [Brutsaert, 1982, Garratt, 1994, Järvi et al., 2011, Meili et al., 2020]. This formulation is used in the present study.

It is often assumed that $z_{\overline{Q},rur} = z_{\overline{\Theta},rur}$ [m] [Brutsaert, 1982, Järvi et al., 2011, Meili et al., 2020]. This assumption is used in the present study.

2. I do not like the approach to calculate a combined BIAS, RMSE, R2 for minimum and maximum UHI, since the performance of the model might be very different for minimum and maximum UHI.

Response: Thank you. We have removed the content related to comparison of the model results with daily minimum and maximum UHI for the Vancouver case.

3. I am a bit surprised about the daily average UHI observations. Are you sure that it is not just the nocturnal UHI that is observed. Given that the UHI has a strong daily variation, it should not be the daily average that is reported, but rather the nocturnal UHI. Maybe it would be better to focus on a subset of observations for which it is actually possible to evaluate the daily cylcle of the UHI.

Response: Thank you. In the main manuscript, all computed statistics for UHI are BIAS, RMSE, and R^2 between the model and observations. In other words, we do not compute the daily average value of UHI in the manuscript.

In the supplementary section, we have carefully examined the comparisons of predicted and observed UHI. When we compare to observations, we specifically note if observed UHI values were diurnally averaged, monthly averaged, or at a specific diurnal time. The supplementary section has been edited as follows.

For Buenos Aires, VCWG predicts UHI values of +2.5, +0.1, -0.5, and +2.4 K at 0300, 0900, 1500, and 2100 LST, respectively. The observed values for the same hours were +2.1, +1, +0.1, and +1.5, respectively. On average, the VCWG predictions of UHI (+1.1 K) are in good agreement with those of the observation (+1.2 K) [Camilloni and Barrucand, 2012]. In case of Vancouver, VCWG predicts maximum and minimum values of UHI equal to +2.7 and +0.1 K, respectively. The observed values for the maximum and minimum UHI were +3.8 and -1 K, respectively [Runnalls and Oke, 2000], in reasonable agreement with the predictions. Case studies in Japan have reportedly obtained urban warming in large and developed cities such as Osaka, which is the interest in this study. This effect is also predicted by VCWG that shows a monthly-averaged UHI of +1.78 K, which is consistent with a monthly-average of +2.2 K simulated using meso-scale modelling [Kusaka et al., 2012]. UHI [K] in Copenhagen is reported to change between +0.25 and +1.5 K depending on the wind speed [Mahura et al., 2009], which agrees reasonably well with the VCWG predictions of UHI [K] varying from a -0.4 K to +1.9 K.

4. Page 2, Line 18: I find this formulation a bit strange : "some efforts have begun by investigators...".

Response: Thank you. We edited the sentence as follows

Recently, multi-scale climate models have coupled meso-scale and micro-scale models [Chen et al., 2011, Kochanski et al., 2015, Mauree et al., 2018].

5. Page 10, Line 3: "this expression should be integrated". This is not very clear..

Response: Thank you. We specified 'over height' in the statement edited as follows

This expression should be integrated over height ...

6. Page 15, Line 30. It seems as if you did one simulation for each month. But why is this necessary, given that the simulations are very quick? Only a spin-up of about 3 days at the beginning would be required. In addition, I find that the spin-up should be rather 2-3 days than 1 day.

Response: Thank you. Some model input parameters should be changed for each period of the simulation. For instance, the leaf area density and leaf area index of tree vegetation vary from month to month. As a result, it was necessary to change such input parameters and run the model again for each month. Future versions of VCWG can take scheduled inputs of such parameters, so that the model can run over extended periods up to a year. As for the spin-up time, we performed

sensitivity analysis, and found that a 1-day spin-up time is sufficient.

7. Page 16, Lines 12-22. The writing style is very repetitive and could be synthetised, perhaps even using a small table. The values for R2 will also be very good if the evaluation is made for an entire year, since the large annual cycle of temperature is obviously well reproduced by the model.

Response: Thank you. We revised the text and removed repetitive writing where possible. We agree that R^2 and other statistics would improve if an entire year was considered all together. However, we were conservative, and we wanted to quantify the error statistics on a month-by-month basis to investigate the model's performance as it varies from month to month.

8. Page 16, Line 26: "similar level of success" $--> $ "similar skill".

Response: Thank you. We implemented this suggestion.

9. Page 16, Line 28: "well-behaved" $--> $ "well captured"

Response: Thank you. We implemented this suggestion.

10. Figure 3: Scatterplots for the entire year are not very useful, since due to the large annual temperature amplitude, it is clear that the agreement between the model and the observations will be good.

Response: Thank you. We agree and that is why we color coded different months of analyses within the scatter plots to show the month-to-month variation. Please note that due to space limitations, we chose to consolidate the scatter plot in this way, while we still separated the scatter plot for each elevation. Other studies in the field use this convention. For instance [Meili et al., 2020] too reports scatter plots of modelled versus observation data over a multi-month period (See their Figs. 4-7).

11. Page 20, Line 5. Not "over predicts the observations", but "overpredicts the values".

Response: Thank you. We corrected this.

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