Geosci. Model Dev. Discuss.,
https://doi.org/10.5194/gmd-2019-77-RC2, 2019

Geoscientific Model Development Discussions

Interactive comment on "An urban trees parameterization for modelling microclimatic variables and thermal comfort conditions at street level with the Town Energy Balance model (TEB-SURFEX v8.0)" *by* Emilie Redon et al.

Anonymous Referee #2

Received and published: 16 July 2019

Overall:

The present paper details an update to the TEB urban canopy model. It demonstrates that the updates made improve comparisons against observations made in an arid climate. It further demonstrates that in warm climates, trees may degrade thermal comfort at night.

The authors are encouraged to compare their updated model not only to their original model, but also contextualize their modelling approach relative to other urban canopy

tree models, e.g. in a Discussion section. How does the current work differ, and what are its advantages and disadvantages? In particular, it is not clear how the current approach offers conceptual and/or operational advantages over other approaches cited (lines 2.28-29), even though it is shown that the current approach is better than the previous one with ground vegetation only. Potential error introduced by combining tree and ground vegetation energy balances is not assessed.

In general, some more discussion of the results presented in the figures, especially Fig. 3, would be helpful in illustrating TEB-tree's usefulness and novelty. For example, there are some variables for which the difference between observations and model output is still appreciable and may require elucidation. Other model outputs do not appear to be realistic (e.g., daytime UTCI in the sun is not reduced with TEB-Tree, which should include impacts of tree shade).

Finally, this paper would benefit from editing for grammar and language.

Specific comments:

2.8: Is scattering accounted for?

The introduction provides an acceptable overview and motivation. The distinction between models that resolve vegetation and "urban canopy models" is not made fully clear – in both cases the scale of vegetation elements is smaller than the model grid.

4.1: How would representing the sides of the crown help?

4.28: How are these parameters defined?

Eq. 4 & 5: These fluxes appear to be defined per plan area fraction. How is leaf area taken into consideration? A particular coverage of trees can have higher or lower leaf area.

Eqs. 6 & 7: It is not clear that this approach can be expected to give accurate results, as we have no reason to expect that QH and QE scale linearly with vegetation fraction at different levels. Stomatal resistances are likely to differ strongly between trees and ground-based vegetation, as are aerodynamic resistances (trees are likely to be exposed to higher winds). As well, how is storage heat flux treated here, given that soil will store a lot more heat than trees?

5.26: Where is equation 8?

5.27: Probably QEg and QEt is meant.

6.10: Which pressure gradient?

6.20-23: Eqs. 11-14 do not allow for the vertical transport of any of the quantities therein. Discussion of how vertical transport is treated should be included in these equations or better, in Eq. 9.

Eq. 11: What is the last term? The square of the friction velocity. How is the friction velocity defined in the urban canopy?

Eq. 15: It appears that LAD is assumed vertically uniform, and therefore turbulent fluxes from trees are assumed to be uniform with height in the tree canopy?

7.15: In Fig. 1 tree crowns are illustrated as uniform layers, not cylinders.

9.11: “only reflected upward” – shortwave is not emitted by trees.

9.12: Why is this re-emitted radiation only upward?

9.10-12: Is it possible to estimate the potential error from this assumption? How much could it affect the Tmrt?

10.2: Citation not in reference list.

Section 6.2: For air temperature and humidity surely this canyon is the wrong scale (too small) to evaluate TEB-Tree? Advective effects are likely to be large?

10.22-30: This paragraph is difficult to understand.

Fig. 1 & Fig. 2: The text appears to indicate that trees do not have sides in this model, but this diagram suggests the opposite.

Fig. 3 d & f: Some of the model-measurement surface temperature differences are very large (>10 K). What is the model missing in these cases? The modelled increase in east wall temperatures in the morning is not reproduced in observations.

11.20: “. . . by trees that are so tall than buildings”. Do you mean trees that are as tall as buildings? Or that are taller than buildings? Can trees that are taller than buildings be implemented in this model?

11.28: Tree temperature = air temperature ?? It seemed earlier that an energy balance is solved for leaves/trees, which means a surface temperature is calculated?

12.13: Some justification into the selection of the mixing length would be useful. 10 cm as a mixing length seems somewhat low. Maybe scale the mixing length as LAD?

Eq. 25: What about the presence of buildings and their effects on mixing length? Is this already included here?

Fig.5: Would perhaps benefit from increased vertical resolution.

Section 6.4: Which version, with or without the length scale modification, do the authors think is best and consider to be “TEB-Tree”?

Fig. 6: Surely TEB-Tree, by virtue of accounting for shade from trees, should strongly reduce UTCI during daytime in the sun relative to TEB-Ref, which does not account for tree shade?

13.22: “at night radiation conditions are the same.” What about longwave radiation? Surely that differs when near a wall at night? Do you mean to say that at night there is no shortwave radiation?

13.30: “It remains 5 C (warmer?) than in TEB-Ref simulations”

Section 6.5: Regarding the degradation of UTCI at night due to trees – are there measurements of this effect (or of increased longwave from urban tree cover) that you can reference, for example, to indicate that your results are in line with observations?

Interactive comment on Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2019-77, 2019.