Review of "Implementation of street trees in solar radiative exchange parameterization of TEB in SURFEX v8.0" by E. Redon et al.

Geosci Model Dev, doi:10.5194/gmd-2016-157

Overview

This article presents a new development to the TEB urban canopy model: addition of effects of trees on shortwave radiation exchange in urban canyons. It appropriately reviews the literature and makes a good case for the importance of this development. The paper discusses the simplifications and assumptions made to generate a fit-for-purpose model addition. It then exhaustively compares the new TEB model with added trees to the old (without trees) as well as to a higher resolution model (SOLENE). The model comparison appears to have been a very large undertaking, and the results are nicely presented. However, there are some significant concerns related to the model formulation, as well as its neighbourhood-scale performance. It may be that the model formulation requires correction and/or improvement. This article has the potential to be a strong contribution, provided the major comments (below) are adequately addressed. Major comment #2 is particularly critical.

Major comments

1. English. Ideally, the English should be edited by a native English speaker.

2. Error in application of Beer's law. Equations 3-5 appear to be mixed up. Eq. 4 with albedo removed should be the transmission; Eq. 3 as written is the intercepted radiation (multiply it by scattering coefficient to equal scattered radiation); Eq. 5 should be modified accordingly. Please check your model implementation carefully to ensure that it is correct according to the updated equations, and redo the simulations if the model equations were incorrect.

3. Neglect of forward scattering. From Eqs. 3-6, it appears that forward scattering of intercepted radiation by vegetation is neglected (see Campbell and Norman 1989 for more detail; also, consider revising lines 7-8 on p. 10). Perhaps the albedo and extinction of the foliage are/can be adjusted to account for this. Either way, please explain and/or justify more fully. Can you assume all scattered radiation is scattered upward without introducing significant error? The broadband scattering coefficient is on the order of 0.50 for the leaves of many trees, and approximately 50% of this is forward scattered – so forward scattering potentially represents 25% of the shortwave radiative energy (very approximately). Interception by lower leaves of radiation forward scattered by upper leaves increases total absorption by tree foliage, which may correct the underestimation you find.

4. Robustness of SOLENE as evaluation tool. How accurate are the SOLENE calculations of solar absorption and scattering by trees? p. 11, lines 7-8: Treatment of foliage in the SOLENE should be further discussed, as well as any associated evaluation, given that this treatment is what TEB

is being compared to. Details are sparse in Robitu et al. (2006). Does it include forward scattering, multiple reflection between tree foliage and the urban canyon underneath, or between different tree foliage elements, for example? Differences in model geometries between TEB and SOLENE are discussed; how different are the physics?

5. Large overall albedo difference. The large differences in mean albedo for higher H/W canyons in Fig. 11 are worrying, and suggests to this reviewer than one or more assumptions made in the formulation in the TEB model are inadequate (assuming the SOLENE model is robust – to point 4 above). It could relate to one of points 2 or 3 above. My sense is that tree foliage limited to the canyon should become less important as H/W increases – if that is true, why would performance degrade? Could this be an issue with the TEB shortwave radiation scheme without trees? A primary purpose of TEB is to provide neighbourhood-scale fluxes to the overlying atmospheric model, and overall albedo is the parameter to which the energy balance is often most sensitive. Hence, this result requires more investigation.

Minor comments

p. 1, line 8: "…uncertainties in terms of the solar radiative exchanges, as quantified by comparison of TEB…"

p.1, line 18: remove "soil artificialisation due to"

p.1, line 22: refresh, or cool, clean/filter, etc?

p. 2: "surimpose" is not a word I don't think – do you mean "shade"? And again, p. 6, line 18 I think "shade" or a similar word (obscure?) might be better than "superimpose" (please check throughout).

p. 3, line 2: "...by a microscale radiation model: SOLENE…"

p. 3, line 12: Krayenhoff et al (2014)

p. 4, line 4: "…radiative (Krayenhoff et al. 2014) and dynamic (Krayenhoff et al. 2015) effects…"; the reference for BEP-Tree is "Krayenhoff (2015)" at present.

p. 4, line 6: "…both within and above the canyon and above roofs."

p. 4, lines 14-19: There are some significant assumptions in the view factor calculations and radiation exchange in ENVI-met that could be discussed. However, since it is a microscale model, it may not be relevant to go into much detail.

p. 4, lines 28-29: I suggest beginning the paragraph as follows: “At each mesoscale model grid point, TEB describes the average characteristics of the local environment by a single urban canyon…”

p. 8, line 6: This assumes tree foliage is uniformly distributed across the canyon, if I understand correctly? If so, this is worth stating in the text.

p. 11, lines 3-6: Is this relevant, if TEB assumes an isotropic distribution? Presumably the same is chosen in SOLENE?

Eq. 19: RMSD (difference, not error, since you are comparing two models); also note the critiques of RMSD relative to MAE (Mean Absolute Error), e.g. Willmott et al. 2009. I suggest calculation of MAE instead.

p. 17, line 9: Reference missing.

p. 26, line 27: Year is 2015, not 2014.

p. 26, line 29: Year is 2014, not 2013.

Appendix A, line 1: Eq. ??; and again line 16 on p. 21.

Appendix A, line 19: View factor from road to trees is zero??? Please explain!

Appendix A, line 8: LAD is in m2 of leaf area per m3 of volume.

References

Willmott CJ, Matsuura K, Robeson SM, 2009: Ambiguities inherent in sums-of-squares-based error statistics. *Atmos Environ* **43**, 749-752.