

Implementation of street trees within the solar radiative exchange parameterization of TEB in SURFEX v8.0 by Redon et al.
gmd-2016-157

Overview

The article is improved in many ways and clearer. In general, the authors have done a good job at revising the paper in terms of the clarity of written language. However, there remain a few key points to address, some areas to improve clarity, and some puzzling results. Overall, there are some key assumptions in the TEB tree model that are not fully expressed in the article, and I am not fully convinced by the utility of comparing the new model with SOLENE, nor are the differences in model assumptions and design fully clear. Finally, Figure 8 suggests that street trees increase solar absorption by walls and roads – both unlikely - and I suggest a different approach to presenting the results. The results in Fig. 9 appear worrisome as well.

Specific comments

Context in Abstract. P1 L16-18: Since these numbers will presumably depend on latitude as well as season, the mean of solar radiation fluxes over the set of observations should also be reported here (or, conversely, these mean absolute differences can be reported as percentage differences) to give the reported differences context.

Forward Scattering is neglected. In my understanding, forward scattering is transmission through the actual leaves and radiation that is reflected downward, not simply radiation that travels downward (forward) by virtue of not hitting a leaf/foilage element. In this understanding, forward scattering and transmission are different processes. Please see the second paragraph of Sect. 3.3.1 in Krayenhoff et al. (2014) and associated references, as well as Campbell and Norman (1998). I suggest the authors simply indicate that they neglect forward scattering; and I suspect that they implicitly include its effects to an extent by choosing tree albedos of ~0.15-0.25, which are closer to average values for a forest (individual leaves scatter/reflect approximately 50% of incident broadband shortwave radiation, by comparison), thereby permitting higher transmission and absorption. If you agree, the fact that effects of forward scattering are also implicitly included is probably also worth stating. It is unclear if SOLENE includes forward scattering, and therefore whether testing against SOLENE provides a helpful evaluation of this approximation in TEB.

Directionality of reflected radiation from trees in SOLENE. P11L31-32: It is not clear how SOLENE deals with reflected radiation. Is it reflected in all directions (i.e., scattered?), or is it directionally reflected? My understanding is that TEB directionally scatters (i.e., reflected radiation from trees is only reflected upward). Does this affect the viability of the comparison?

Value and meaning of tree albedo. P12L24-25: Albedo of trees in SOLENE is 0.25, and it is 0.15 in TEB simulations (Table 2), or 0.25? Please clarify. Are the albedo values at the same scale in both models? I.e., in TEB the tree albedo is an integrated value for the whole vegetation layer; since SOLENE represents independent portions of the foliage, what does the foliage albedo mean in its case (see previous comment)?

Mean absolute difference. I suggest using the term MAD (=Mean Absolute Difference) instead of MAE (which I suggested in error), since this is a model difference, not an error. There are no errors calculated in the article as far as I see, only differences. Please correct throughout.

Neighbourhoods with trees taller than buildings are common. P6L32: This paragraph appears to have a strong European bias. I would estimate that perhaps the majority of urban neighbourhoods in North America, being low density, exhibit trees that are taller than buildings. This assumption therefore limits the range of neighbourhoods to which this new TEB tree model can be applied. It is important that this limitation is stated in this paragraph – perhaps it is a good candidate for ‘future work’ at the end of the article.

P8L4: “...the Beer Lambert law...”

P18L28: “confounded” is best replaced by “combined” or similar. Please correct throughout.

Unclear model results. Sect. 6.4.1 and Figure 8: Trees should reduce absorbed shortwave radiation on walls and especially road. If I understand correctly, the divergence from expectation is due to the garden vs. road fraction. Additionally, trees will generally reduce wall shortwave absorption, but we do not see this result in the figure. As such, I am not clear regarding the utility of Fig. 8; what do we learn from it? I wonder if illustration of a few key example scenarios (rather than combining all simulations) might better illustrate the different effects of trees when represented as “high” vs. “low” vegetation. Overall, the clarity of the writing in Sect. 6.4.1 requires improvement.

Apparent model error. Sect. 6.4.2 and Figure 9: These differences due to trees appear excessively large. I think something may be incorrect. If you look at Fig. 6c of Kravynhoff et al. (2014) you will see that overall albedo varies little as a function of tree foliage presence (or lack thereof) and tree foliage height – for one point in time. What do your results look like (what is the effect of trees) for one particular point in the middle of a summer day? Do these large differences result from the diurnal averaging or the model implementation? Moreover, I suspect overall albedo should be lower in the TEB reference simulations given input road and wall albedos, and canyon albedo should definitely decrease with increasing H/W. Therefore, there appears to be something incorrect in these TEB reference simulations as well. The last paragraph on P19 contains some errors of interpretation in my opinion: a shallower canyon (lower H/W) yields less radiation trapping, less absorption (per horizontal area), and higher albedo. Trees can have multiple effects; if their greater sky view factor and reflectivity are more important than their trapping of solar radiation deep in the canyon, they can reduce absorption, otherwise they can increase it. Moreover, it has been found that trees have a smaller effect as H/W increases (e.g. Coutts et al. 2016, Theoretical and Applied Climatology). Fig. 9 suggests the opposite. It

seems clear that there is a problem with these results. The clarity of the writing in Sect. 6.4.2 also requires improvement.

P22EqA6-A8: It is not clear what “hcw” represents, nor where these equations derive from. Please provide more details on both fronts.

Integration limits for view factor calculation. P23EqB1-4: The choices of integration limits here appear arbitrary. Are model results sensitive to the choice of these limits? More importantly, the middle of the walls ($h/4$ to $3h/4$) is weighted more heavily in these view factor calculations. It seems critical to me that all parts of the walls be weighted equally in the view factor calculation. So, for example, the $3h/4$ to h should be more important for wall-sky view factors than $h/2$ to $3/4h$, if the latter is already used for wall-to-wall view factor calculation. Please address this in the model design, or defend your choice in the article.