

Geosci. Model Dev. Discuss., author comment AC2  
<https://doi.org/10.5194/gmd-2021-81-AC2>, 2021  
© Author(s) 2021. This work is distributed under  
the Creative Commons Attribution 4.0 License.

## Reply on RC2

Nils Wallenberg et al.

---

Author comment on "Locating trees to mitigate outdoor radiant load of humans in urban areas using a metaheuristic hill-climbing algorithm – introducing TreePlanter v1.0" by Nils Wallenberg et al., Geosci. Model Dev. Discuss.,  
<https://doi.org/10.5194/gmd-2021-81-AC2>, 2021

---

Thank you for your valuable comments! They have helped us clarify some parts which might have come out unclear. Specific answers to questions and comments are given below.

Comment #1 @ line 130-135:

Difference between random vs genetic?

Answer:

The differences between the random and genetic algorithms in assigning starting positions are described in Sect 2.2.2 (typo in text fixed from 2.2.1 to 2.2.2).

Comment #2 @ line 145-150:

If you would use all of these settings with hill climbing (if possible), what would be the required time?

How do you define the necessary number of iterations? On what does that depend?

Answer:

The examples in the text are just to show the extensive number of brute-force calculations required to find optimal locations in comparison with example numbers with the hill climbing algorithm. The numbers in the hill climbing algorithm could be increased a lot and still not come close to the brute-force calculations.

The necessary number of iterations is set by the user, but would in the end depend on e.g. how large the model domain and “planting area” is, how many time steps are used, number of trees, size of trees, etc. Increasing the number of iterations will increase model runtime, but also increase the probability of finding suitable locations for the trees.

Comment #3 @ line 170-175:

What is defined by “close enough”? Depending on tree crown diameter or something else?

Answer:

Thank you for your comment. This, obviously, needs a more detailed explanation. “Close enough” means if it is even possible for the tree shadows to overlap. This is estimated by calculating the Euclidean distance between the longest parts of the tree shadows. Following clarification will be added to the revised manuscript: “Here, large distance is defined as the largest Euclidean distance between the northeast and southwest corner or the largest Euclidean distance between the northwest and southeast corner, of the estimated tree shadow for the generated tree.”

Comment #4 @ line 215-220:

How do you decide this? On what does it depend?

Answer:

This is defined by the user (user of the tool/model), so it depends on the user. It can be set in the model GUI (*Number of trees to plant*). Will add *User* to revised manuscript to clarify: “User decides number of trees ( $k$ ) to optimize locations for in respect of  $T_{mrt}$  mitigation.

Comment #5 @ line 245-250:

Add geographical coordinates and elevation.

Answer:

Coordinates and elevation will be added to the revised manuscript.

Comment #6 @ line 260-265:

Why these two periods? Is the second part of the first period?

Answer:

The second period corresponds to a short time span in the afternoon when excessive heat is most pronounced. Clarification will be added to the revised manuscript.

Comment #7 @ line 260-265:

Not clear.

Answer:

Tree sizes small, medium and large are described in Table 1. Clarification will be added to the revised manuscript.

Comment #8 @ line 265-270:

Why this number?

Answer:

Indeed, this needs clarification. This is for the model to have enough iterations to avoid that the tree locations are in positions which are not necessarily optimal or satisfactory. Of course, we do not know if the locations determined after 20000 iterations are optimal, but they should definitely be adequate (as described in Section 4). To conclude, we chose this number because it is a very large number of iterations.

Comment #9 @ line 265-270:

Why locations for trees differ substantially due to their size? This should be discussed here or in Discussion section.

Answer:

This has been discussed in Sect. 5 (Discussion). The main reason for the different positions with different tree sizes is that the trees would cast shadows of different sizes. The whole idea of the model is to use the tree shadows as efficiently as possible. This means that if two tree shadows overlap they only count once for the overlapping pixels. Therefore, the model would locate the trees in places where they do not overlap other tree shadows.

Comment #10 @ line 285-290:

What about individual hours? Are there big changes?

Answer:

Interesting question. We considered adding examples of individual hours, but eventually decided to exclude them as we find it likely that users will base model runs on several time steps. The reason for this is that heat stress not necessarily is confined to one time step. For example, high Tmrt (over 50-60 °C) is likely to occur over a longer time span on hot and clear days in e.g. Gothenburg. Still, to answer your question, tree locations will differ a lot if running with single time steps as an effect of the azimuth of the sun. A sun azimuth in the east will, for example, increase Tmrt in front of sunlit west facing facades and a sun azimuth in the west will, similarly, increase Tmrt in front of sunlit east facing facades.

Comment #11 @ line 300-305:

Edit language.

Answer:

Thank you! Will be revised.

Comment #12 @ line 340-345:

Results from this table should be discussed in the main text. We can see that genetic starting algorithm is generally better. However, when 6+ trees are used, it is worse than random starting algorithm? Why this happens?

Answer:

Thank you for this important question! This is analyzed and discussed in Sect. 5 (Discussion). The way the genetic algorithm for starting positions works is that it will determine the starting positions of an iteration based on the “optimal” positions in the previous run. Therefore, as the model runs, the starting positions will come closer and closer to “warm” areas in the Tmrt rasters, which in this case are confined close to the walls of the buildings in the center of the “Planting area”. This means that if the trees are starting in positions which are close to each other the model will have to adjust for overlapping shadows and adjusting for overlapping shadows is time consuming.

Comment #13 @ line 340-345:

Are these numbers in seconds (s)? If yes, add (s) in column names above them.

Answer:

Thank you for noticing! This will be fixed ((s) will be added to the table column names where appropriate).

Comment #14 @ line 350-355:

Can you explain/discuss why this happens?

Answer:

This is mentioned in the discussion and could be explained by the fact that metaheuristics are not guaranteed to find optimal solutions. Nevertheless, the solutions found here (i.e. tree locations) have high mitigating potential. One way of lowering the chance of this is by increasing the number of iterations.

Comment #15 @ line 365-370:

Why this happens?

Answer:

This is discussed in Sect. 5 (Discussion).

Comment #16 @ line 460-465:

Language should be improved.

Answer:

Thank you! Sentence will be revised.

Comment #17 @ line 585-590:

Yes, this is very important and I am glad that authors mentioned this. I am wondering how many of the trees could be really planted in the study area if this was considered (rhetorical question). I guess that would be quite a small number (maybe even 0).

Answer:

Thank you for your comment! This is definitely something for future improvement of the model. It would, however, require data which is hard to acquire.

Comment #18 @ line 585-590:

Thank you! :)

Answer:

You're welcome! :)

Comment #19 @ line 615-620:

Yes, this tool can be an important first step in the decision-making process where to plant trees in cities. However, the situation on the ground would certainly modify the proposed solution to some extent.

Answer:

Yes, the situation underground (i.e. soil characteristics, root spacing, etc) would definitely modify the proposed solution. However, the tool, as you mention, can be used as a first step in decision-making. Future work should include an evaluation of these locations and their underground properties.