Biogeosciences Discussions

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Comment on bg-2021-242

Anonymous Referee #2

Referee comment on "Carbon sequestration potential of street tree plantings in Helsinki" by Minttu Havu et al., Biogeosciences Discuss.,
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Review of bg-2021-242, Havu et al.

This paper reports on a modeling study of two urban street tree sites in Helsinki, Finland. It exploits a multi-year time series of field observations of tree sap flow, physiology, and soils for the two sites. Such measurements are rare in urban sites and using them to parameterize the models is a great strength of this project. Previous studies have measured and/or modeled urban tree net CO2 exchange over one year to a few year's time. A significant new contribution of this study is that it couples an urban land-surface model (SUEWS), which is capable of representing photosynthetic CO2 uptake and respiratory CO2 release by the tree canopy in response to environmental drivers, with a soil carbon model (YASSO) which is capable to soil organic carbon fluxes and pools for the same conditions.

The modeling system and is parameterization are well documented and appropriately validated. The paper is well organized and generally well written (but see note below). The manuscript and its conclusions could be strengthened by moderate revisions, which are noted below.

General comments:

1. Please explain more about how the study being on juvenile trees affects your overall conclusions. Plant relative growth rate will change as the tree size gets larger. What is the typical longevity of these tree species-- in "nature" and also what is typical maximum age in the urban environment? Given the way the paper is framed around urban tree C sequestration potential and management for climate, it is likely that some readers could misunderstand or incorrectly extrapolate the findings to a mature urban forest or to the lifetime of the trees. It would help a lot if these points could be discussed when you are interpreting the main messages of your conclusions, including adding cautions or caveats

where appropriate.

2. The aim of the modeling integrations to estimate the tree/soil C budget is clear, and it is a novel contribution. In fact, it is really something like site-based net C exchange, and perhaps it is not wrong to call it "sequestration potential". However, again for a general audience and for land managers who would read your work, it would be very helpful to explain how this relates to carbon sequestration as a climate concept. There, we normally think of carbon sequestered as being removed from the atmosphere and stored for a climatically relevant length of time (w.r.t. to fossil C emission reductions), such as 50-100 years or longer. How does a climatic concept of C sequestration relate to the urban system that you have modeled here? How long would the trees live or be allowed to grow on site before they grow too large (height interfering with wires, roots interfering with pavement, etc.), or before they die from insect outbreaks, urban heat, drought, road salting in winter, mechanical damage, etc.? What is the normal replacement interval for street trees like this? I am not asking that values be added for all of these factors; however, it would strengthen the paper if you can explain more specifically in what ways your results could relate to long-term carbon sequestration, and in which ways they do not.

3. It's understood that this is a modeling study, but it would strengthen the paper if the discussion included some comparison of your results to other field or modeling based studies of urban annual net biogenic (tree/soil) C exchange. There are some from northern climates such as Vancouver, Minneapolis, London?, even Helsinki. Broadly, how do the conclusions here compare to those obtained for tree-covered landscapes in cities that have been obtained through flux measurements and/or model upscaling?

4. Please check for consistence of verb tense throughout the paper. In places it switches back and forth between past and present tense.

Detailed comments:

Does the soil freeze to a significant depth in winter at these sites? How was frozen soil handled in the YASSO simulations (does Rsoil decline or even stop)?

line 129: Do you know how high was the groundwater table at the two sites? Did the level vary by season and, if so, how would that have affected the results? And a related question: Was any irrigation used at the sites? (I am assuming not regularly because it was not mentioned in the manuscript.) However, was it used during the early years of the trees' growth--it is common for irrigation to be needed in the first 2-3 years after establishment, depending on the local precipitation regime.

line 282-3: Aboveground litter was ignored in the simulations on the basis that the autumn leaf fall of these deciduous species is normally removed. This is a reasonable approach for modeling the C exchange of the "tree site" itself. However, I think you should take this issue further in the discussion and conclusions of the paper because you have "framed" the paper around urban tree plantings and sequestration. What would be the consequence of leaf litter fall for your annual carbon budget and how would this affect your overall conclusions and implications for how urban tree plantings affect the urban C budget?

line 321: Canopy densification was ignored (stopped) in the model after a certain year, based on the fact that these trees were pruned annually after they had reached that age. However, the biomass of leaves and branches removed by pruning would presumably be used to create mulch or compost or biofuel, etc, thereby all being released to the atmosphere. So, similarly as in the comment immediately above, how would the exclusion of the pruned biomass affect your annual carbon budget and what are the implications for your overall conclusions? If it is possible to make a quick quantitative estimate of these two carbon losses (collected litter and pruned biomass), that would be a nice addition that would strengthen the paper. If it is not possible to have a quantitative value, then it would at least be good to add these points to the discussion and the explanation of conclusions about the total C budget from urban trees.

line 398: "climate neutral" is not quite correct, in my view. First, there are, of course, other effects of trees on climate besides net CO2 exchange. Second, there is the point about the model simulations being focused on the tree/soil system. I'd suggest writing "carbon neutral", and with the caveat that it's from the point of view of the tree/soil system (without the exports of leaf litter and pruned biomass).

line 426: When you discuss year-to-year variability, can you also say something about how important was the effect of annual differences in growing-season length, or timing? Especially in cold climates, these two factors can be important for annual C exchange, beyond only the variation in Tair.