

# Response

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## 1 Anonymous Referee #1

The authors have done a great deal of work in reframing the discussion. Figure 10 is of great added value. Nevertheless, some more information should be provided as asked before and should be added to the manuscript in a synthetic way; there is potential for development in the appendix.

My previous comment on the implication of LAI quantification for the modelling study is critical. Would there be other ways to gather the LAI if one does not have access to these photos? How uncertain is the LAI quantification? Could you run some simulations to test the implications of such uncertainty? Simply referring to the paper by Heusinger and Weber is not enough. Especially considering that the aim is to have this model fully coupled to regional climate models.

The observed LAI is only used in the pre-calibration process and to roughly evaluate the modelling. Quantifying the impact of the LAI uncertainty on modelling would imply doing sensitivity test on the calibration process itself rather than on the final calibration. However some more details can be given on the LAI measurement. Estimation using RGB photo analysis is the 'reference method' for this type of site. But there are other ways to estimate the LAI, as investigated in a masters thesis which looked at modelling the green roof LAI by a semi-empirical function (just weather data) and an optimized version of it (containing substrate water content). The results can be seen on the Figure 1, they show that the LAI estimation for all 3 methods is quite similar.

Also, more context should be provided on how transferrable these outcomes are to other similar green roofs.

For water and energy issues, the works of de Munck et al. (2013) aimed to provide a standard configuration of extensive green roofs in order to perform city-scale green roof implementation scenarios, which was tested in the study of de Munck et al. (2018). The work presented here builds on this transferable model by adding the modelling of sedums, which are the most common type of vegetation on extensive green roofs. In addition, the experimental green roof site used here for calibration and evaluation and the one used by de Munck et al. (2013) are quite comparable and well representative of standard green roofs, making the new carbon flux modelling module relevant for the realization of

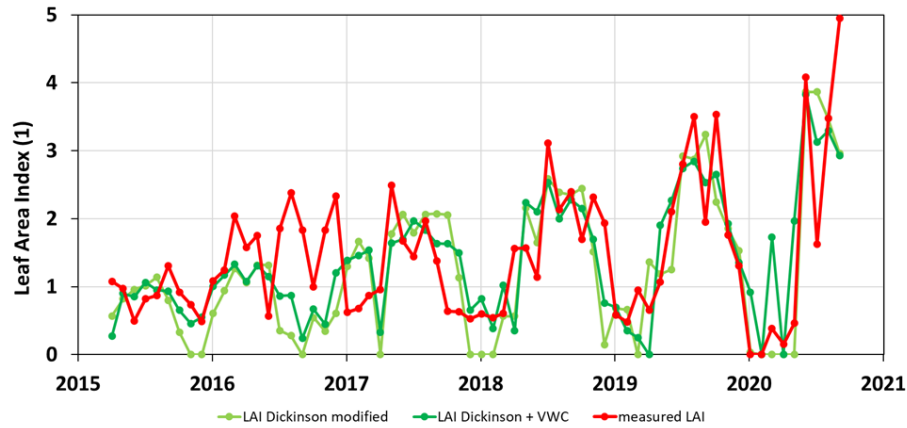


Figure 1: Comparison of the three LAI estimation method tested on the green roof site.

large-scale scenarios taking into account carbon fluxes from the new calibration.

de Munck, C. S., Lemonsu, A., Bouzouidja, R., Masson, V., and Claverie, R.: The GREENROOF module (v7.3) for modelling green roof hydrological and energetic performances within TEB, *Geosci. Model Dev.*, 6, 1941–1960, <https://doi.org/10.5194/gmd-6-1941-2013>, 2013.

C. de Munck, A. Lemonsu, V. Masson, J. Le Bras, M. Bonhomme, Evaluating the impacts of greening scenarios on thermal comfort and energy and water consumptions for adapting Paris city to climate change, *Urban Climate*, Volume 23, 2018, Pages 260-286, ISSN 2212-0955, <https://doi.org/10.1016/j.uclim.2017.01.003>.  
Once this is addressed, the paper can be accepte

## 2 Anonymous Referee #2

General comments I thank the authors for modifying the manuscript according to my comments. However, additional clarification is needed. Specifically, the discussion section on dynamic vegetation seems a bit disorganized, can you provide some context on the implications of using other LAI assignment approaches? Please also provide line numbers where the text is modified to facilitate a faster review process.

Specific comments 1. Lines 10-12: ‘The five years of measurements were used to do a sensitivity analysis of the photosynthesis module parameters in order to quantify their influence on the photosynthesis’ → ‘Based on the five years of measurement data, a sensitivity analysis is conducted to quantify the significance of selected parametrisation parameters on the photosynthesis process’,

modified in the manuscript

2. Lines 31-36: Same as the original comment, please put the amount of direct carbon sequestration into perspective, i.e., how much is considered significant or trivial?

As explained in the paper of Heusinger et al. (2017), the direct carbon sequestration measured on the green roof is equivalent to the direct sequestration mean values of several grassland in Europe ( $-150 \pm 200 \text{ g C m}^{-1} \text{ year}^{-1}$ ; Gilmanov et al., 2007). In this perspective, even if the direct sequestration seems negligible in comparison to indirect sequestration (estimated at 7680, 7222, and 6393  $\text{g C m}^{-2} \text{ yr}^{-1}$  according to Seyedabadi et al., 2021), direct sequestration can still be investigated since it compared with the sequestration found in natural areas.

3. Figure 1: If the measurement setup information is available in other papers, then I suggest moving this figure into the appendix or supplement as it doesn't add any valuable information,

Modified in the manuscript, the Figure was moved to the appendix

4. Line 124: 'due tu'  $\rightarrow$  'due to',

Modified in the manuscript

5. Line 138: remove 'which allows for the',

modified in the manuscript

6. Line 165: add '(Rleaf from Eqs. A10-11)'

modified in the manuscript

7. Line 170: remove 'that is'

modified in the manuscript

8. Section 3.3: Please be extra clear that Equations introduced here in the main text are only the modified ones. And introduce all variables used in the sensitivity test (especially those with their equations in the appendix,  $\Gamma$  and  $\epsilon_0$ ) here or in some other places in the main text,

The modified equations were further introduce with the sentence LINE 181 'which modifies the equation for ... '. All variables were further introduced in the sensitivity analysis section LINE 302 ' '

9. Line 189: 'see Appendix eq. A2 and A3'  $\rightarrow$  'denominators in Eqs. A2-A3',

Modified in the manuscript

10. Lines 210-213: The added sentences do not provide any constructive information, either delete 'This empirical ... faster growth cycle.' or explain the reason for such a simpler formulation after 'for herbaceous plants' on Line 210,

Modified in the manuscript, this sentence was deleted.

11. Line 218: ‘set to’ → ‘prescribed during the calibration to’

Modified in the manuscript

12. Equation 15: Please provide a citation to the formulation of Di and Ri, This simplified formulation can be found in the PhD thesis of Raphaël Garisoain: "Évolution du cycle du carbone des tourbières pyrénéennes dans un contexte de changement climatique global : observation et modélisation". Sciences de la Terre. Institut National Polytechnique de Toulouse - INPT, 2023. Français. NNT : 2023INPT0124. tel-05031426. It was specified in the manuscript LINE 213 : ‘the principle can be expressed as follows (Garisoain, 2023)’

13. Table 1: As originally suggested, please provide references to the chosen parameter values,

The references are now added in the Table 1 description.

14. Section 5.1.1: I understand the authors’ desire to keep this part in the main text. However, perhaps not in the current form, as the text is technically heavy and rather difficult to make sense of as a general urban modeller. Please reorganize the information and consider adding a flowchart to facilitate the algorithm description visually. A flowchart was added to the section 5.1.1.

15. Authors’ response to (original) Section 5.3.1: Please add this information to the main text,

The response was added to the manuscript LINE 362 ‘The observed LAI was estimated by capturing the variation of the green chromatic information (green fraction) in the RGB space from photographs taken at 10 different randomly selected locations on the roof, approximately one a month (Heusinger and Weber, 2017b)’

16. Line 321: ‘eight parameters’ → ‘eight parameters (Table 2)’

Modified in the manuscript

17. Table 2: Please add a column to list the references for calibration ranges. Also, what are the ‘??’ in F<sub>2max</sub>?

Modified in the manuscript, ‘??’ were removed in the manuscript

18. Figure 8: ‘indicate standard deviations’ → ‘indicate one standard deviation’,

Modified in the manuscript

19. Section 6.1: Consider changing the section head to ‘Sensitivity in sedum parameters’

The section head was change to ‘Sedum model response to micro-meteorological conditions’ LINE 423

20. Figure 10: Consider changing the Caption to ‘Evolution of the modelled

(lines) GPP with (a) volumetric water content (VWC,  $\text{m}^3 \text{m}^{-3}$ ), (b) photosynthetically active radiation (PAR,  $\text{W m}^{-2}$ ), and (c) temperature ( $T_s$ ,  $^{\circ}\text{C}$ ), for the parametrisation of Sedum, ISBA C3, ISBA C4, and the comparison against selected observation (dots).’ And move ‘For comparison, the observations are ... values for photosynthesis’ to Lines 474-475, which provides more context and details in the main text while keeping the essential information in the figure caption without repetition.

[This was modified in the manuscript according to the comment](#)

21. Continued: Not sure if I understand this part ‘For each ...on the site’,

[The confusing sentence was removed in the manuscript](#)

22. Line 445: ‘quantify’  $\rightarrow$  ‘quantifies’, I also suggest keeping ‘(NEE)’ in the sentence,

[modified in the manuscript](#)

23. Line 490: ‘were’  $\rightarrow$  where,

[modified in the manuscript](#)

24. Line 493: ‘energetic’  $\rightarrow$  energy,

[modified in the manuscript](#)

25. Lines 495-496: ‘But, Zhou et al. ... for long term simulation.’ Not sure if I understand this.

[The confusing sentence was removed in the manuscript](#)

26. There are places with spelling and grammar errors throughout the main text and the Appendix, please check carefully.