



November 29, 2017

Titta Majasalmi
1431 Ås, Norway

titta.majasalmi@nibio.no

JOURNAL OF BIOGEOSCIENCES

Editorial office

Dear Associate Editor, Kirsten Thonicke,

Please find enclosed our revised manuscript “An enhanced forest classification scheme for modeling vegetation-climate interactions based on national forest inventory data”, by Titta Majasalmi, Stephanie Eisner, Rasmus Astrup, Jonas Fridman and Ryan M. Bright. We are grateful for your comments and have invested substantial attention and effort to ensuring that yours -- along with and other reviewer comments -- have been carefully addressed. You will find that all sections in the manuscript were revised following the reviewers suggestions, and we believe the quality of the paper is greatly improved.

On behalf of all authors,

sincerely,

Titta Majasalmi

Corresponding author

Comments to the Author:

Thank you for submitting your carefully formulated author responses! I think it is very important to address the 4 major points of reviewer 1 in the revised manuscript as you rightly have announced.

- The Introduction and Materials and Methods (M&M) were fully revised. Introduction presents the appropriate context, and in M&M data and methods were separated. The role of crown length (CL) and Leaf Area Index (LAI) in modeling surface fluxes is explained in Introduction (p.2: r. 5-10), and the fact that the forest variables are not independent from each other is explained in M&M (p.5: r. 24-26). The differences between our Land Cover (LC) -product and the ESA LC-product are now presented in results section (**Fig. 4.**, **Fig. 5.** and **Table 4.**, and discussed on Discussion section (p.12-13: r. 20-2). In addition, discussion was revised to correspond with the new result section (e.g. p.13-14: r. 18-2).

It is also important to use the latest version of CCI_LC product as you agreed in your response to reviewer 2. In my view it is ok not to add subfigures in Fig. 4 (response to reviewer 2).

- The newest ESA LC-product (v.2.0.7) was used.

I also agree with you that it is important to provide the information where the MS-NFI maps can be requested. Would it be possible to provide them open access, given that you get a data DOI before?

- The missing information for requesting MS-NFI data for Norway was added (p.14: r. 22-23). Our products (i.e. the enhanced LC-product and the respective percentage layers will have open access and doi. Requesting doi means that no further changes of the files are possible – so we must wait until our paper is accepted before requesting the doi).

I have a few comments to make:

Response to Reviewer 1:

1. Please also double-check that the revised manuscript text adequately explains this point:

R1: page 6, lines 1-6 if you classify based on V and H, why do you originally cluster with CL and LAI? Especially since you correct the original clusters with V and H and MD?

Your response: "The LUT values represent medoids of the four-dimensional (i.e. V-H-CL-LAI) clusters of the twelve forest classes (3×species group × 4×subgroup). Related LC-product is needed to apply the LUT to obtain Fennoscandic maps of V, H, CL and LAI. The LC-map to apply the LUT was prepared using MS-NFI maps, and MS-NFI maps were classified based on V and H to simplify the classification task (p5, r6-7).

o The clusters are not corrected using MD, but it is used to determine cluster-membership (i.e. into which group an observation with certain V and H combination belongs to based on smallest median MD (i.e. for each subgroup a gridded representation median MD values was calculated, and the Fig. 2. was formed by assigning each grid cell location for the subgroup which had the smallest median MD) (p5, r7-13)"

- The M&M section was revised (p.5-6: r. 20-22). First paragraph introduces the variables and why they were chosen for clustering. Second paragraph explains how number of clusters was determined and how the clustering was done. Third paragraph describes how MD was applied to solve cluster memberships.

- The reason for incorporating all four variables into clustering analysis is explained in line (p.5: r. 24-26) (i.e. the variables are not independent from each other). V and H were only used to define cluster memberships in order to apply the classification for MS-NFI map data as pointed out in p.5: r. 26-27. MD was only used to assign each V-H-combination into one of the four-dimensional clusters and is described in p.6: r.13-22.

2. It will be important to provide information on the algorithms used in addition to the R routines, cf. Reviewer #3 comment:

R3: Method lacks in depth explanations and references are missing. For example, on several occasions, authors are quoting R routines with their cryptic abbreviations, but not providing any information or reference what is the basis for the algorithm used in that code.

Your response: "We can revise description of the methods and add citations to used algorithms/methods."

- We have added references and clarifications.
- For example, to determine the optimal number of clusters we enhanced the method description (p.5-6: r. 29-3) and reference for R package was added (p.6: r. 2).
- The description of the clustering was also modified and references were added to both for method (p.6: r. 7-8) and R package (p.6: r. 11). The clustering method and application is explained in (p.6: r. 3-11).
- A reference was added to describe MD (p.6: r. 15). The definition of cluster boundaries is explained in p.6: r. 17-22.
- We added references to 'rgdal' and 'raster' packages (p.7: r. 19) (i.e. they only contain basic tools for reading, processing and analyzing geospatial data in R).
- For confusion matrix calculation, we added reference to 'caret' package (p.8: r. 3) and revised the section to explain how to interpret the confusion matrix (p.7-8: r. 31-3) (the information was also added to **Table 4**. Figure caption for reader's convenience).

3. in your revision of the introduction as well as Material and Methods, please make sure that the land-cover classes are clearly separated from PFTs in their definition.

- This was clarified throughout the manuscript.

4. Please make sure this point is adequately addressed (i.e. clearly described and discussed) in the revised manuscript.

R3: "This is for at least two reasons: 1) regional climate models operate on 1-10 km resolution, and 2) LC classes need to be converted into PFTs (by cross-walking procedure). The question is how different would these 2 PFT maps converted from enhanced and original LC maps appear after aggregation to coarser resolution and cross-walking. Therefore, I suggest authors rewrite the article and clearly explain what they have done or to perform an analysis as I have suggested above. The latter approach would certainly serve to link the climate modelling and forest observation community, as they seem to aspire in the manuscript."

Your response: "As our enhanced LC-product has an attached LUT of the key forest structural attributes, no cross-walking procedure is needed, i.e., our LUT may be applied to forest classified pixels directly. Cross-walking is only needed to convert the ESA LC-product to a PFT-map. The influence of data aggregation to coarser resolution on raster values will be analyzed and discussed in

the revised manuscript. We agree that that our paper needs substantial revision, and that the suggested corrections and analysis steps will increase the impact of our paper."

- The resolution difference between different LC-products is described/brought up in Introduction (p.3: r. 11-12), in M&M (p.7: r. 22-25), and included in Discussion (p.12: r. 26-32).
- The representation of LC classes in land models and LC-class to PFT conversion (i.e. cross-walking) is introduced in Introduction (p.2: r. 10-17).
- To follow the reviewers idea we decided to demonstrate the potential of our enhanced LC-product to improve the description of maximum growing season LAI (LAI_{max}) of managed forests in Fennoscandia – we compared our LAI_{max} map with reference LAI_{max} maps created using the ESA LC-product (and related cross-walking table) and PFT-dependent LAI_{max} values used in three leading land models. The new section was added to M&M (p.8: r. 5-26), to results (p.10: r. 19-27), and to Discussion sections (p.13: r. 21-29).
- As both LC-products have the same spatial resolution, data aggregation to lower resolution is not needed to show that the two LC-products and different PFT-dependent LAI_{max} values results in differently looking maps of LAI_{max} (i.e. our LAI_{max} map shows clear spatial patterns, and LAI_{max} variation with latitude, whereas the reference LAI_{max} maps remain constant).
- We are confident that this section now sufficiently answers R3's question of: "how different would 2 PFT maps converted from enhanced and original LC maps appear after cross-walking?"