

Throughout paper Chlorophyll should be chlorophylls.

REPLY: The laboratory reference measurements have differentiated between chlorophylls a and b, while the values from spectral indices only indicate the total (a+b) chlorophyll content. Made a few changes to make this clear.

This Associate Editor agrees with a comment on the interactive discussion C8386 that sampling points at 20nm bandwidth does not constitute “hyperspectral data” should be changed to “multispectral”. In all other optical RS domains this would be regarded as multispectral. In addition, all the indices presented are two band multispectral.

REPLY: As we have named our instrument Hyperspectral Lidar (HSL) and it has become known by that name, we have kept the instrument name as it is. As concerns the data or the method in general (multispectral laser scanning or multispectral data) we have followed the Editor's request and changed hyperspectral to multispectral.

A table or some method should be included mapping the wavelengths used in this paper to the wavelength in the Equations from the previously published indices presented

REPLY: Added table 1 to illustrate which wavelengths are used for each index.

Throughout the paper, the use of “about” is rather unscientific.” Approximate” should be used instead.

REPLY: Replaced about with approximate

The associate Editor previously commented “The issue of shape was commented on by one of the 1st reviewers. This has not been addressed and needs to be. The comment was Shape - this is never defined, described or explored in any depth. Location of needles on branch? Reference to shape needs to be expanded or removed.” The use of the terms morphology and form may help resolve this

REPLY: Replaced the word “shape” with “structure”, edited the first paragraph of chapter 3 and added a reference to article (Raumonen et al., 2013) to Ln 182 (revised version), where more information about 3D tree modeling can be found.

Throughout the Figures “ $\mu\text{g}/\text{cm}^2$ ” of what?

REPLY: Chlorophylls a+b content per needle surface area. Added the note about surface area to Fig3 caption. Figs 4 and 5 are basically same, only with different index, as stated in their captions.

L18 “The photosynthetic activity in tree canopy is an indicator of tree health.” Should be something like “The photosynthetic activity of leaves within a tree canopy is an indication of tree health.”

REPLY: Changed as suggested.

L61 there is no blue wavelength so cannot be considered “white”

REPLY: Added the wavelength range of the laser (420-1680 nm), which can be considered white. The lack of blue channel is a limitation on the detector side.

Ln 126 “The overall shape of the tree and changes in shape from May to November can be observed in Figure 1 where no spectral information is used. The changes in the shape and the spectra of tree parts are

visible in the spectral point clouds.” The 1st sentence states not spectral information the 2nd states there are “...spectral point clouds”. I do not understand what is meant.

REPLY: The first sentence refers to fig 1, and second refers to fig 2. Changed the text to be more understandable.

Ln176 “ ...grown new needles 09-12 and dying and falloff of old needles (shown in bluish green , low...”
Reference to “bluish green” should be removed. They are subjective terms and depend on readers’ eyesight

REPLY: Removed “bluish green”

Should the Equation identification number not be cited in the text?

REPLY: Added references to the equations.

Ln219 “reflectance is not completely removed. Further study would be required to produce a physically ...”

REPLY: Corrected

Ln 201 “We demonstrated that the seasonal changes in the shape and physiology of tree parts are ...”. The terms canopy and leaves should be used for photosynthesising components and possibly branches for structural items if there were being discussed

REPLY: Changed to “We demonstrated that the seasonal changes in the morphology of tree canopy, needles and branches are visible in 3D;...”

Ln “209 signal that has the potential to eliminate many of the multiple scattering and geometric ...” then Ln 218 contradicts this in part . “However, the influence of multiple scattering effects to the measured backscattered reflectance is not completely removed.” And on to Ln 221. The text needs to be tightened up here

REPLY: Moved the paragraph Ln 208-217 to the end of Chapter 2, materials and methods, and edited the paragraph starting on line 218.

The text in paragraph starting on Ln 218 seem to be incomplete. Can be overcome by LIBERTY. So should we give up on Vis and this laser method and use LIBERTY instead? That is what is implied.

REPLY: Rephrased the paragraph to more clearly state that while we believe that LIBERTY might be beneficial, further study is required to validate this.

Ln231 There is repetition in this paragraph and it should be rephrased.

REPLY: Rephrased.

Ln 238 Has a vast amount of research not already tried to optimise spectral indices for different applications. I suggest only optimising the laser band to match these is what is important to take this system forward

REPLY: Thank you for the suggestion. We will keep working on this.