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Interactive comment on "Technical Note: Hyperspectral lidar time series of pine canopy physiological parameters" *by* T. Hakala et al.

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Received and published: 30 January 2015

"I think this paper in general presents interesting results from a new hyperspectral lidar instrument. This kind of measurement is likely to hold real promise for disentangling structure and spectral properties of vegetation canopies. The work is generally clear and well-written. I have a few comments on the limitations, but these are fairly minor. "

RESPONSE: Thank you for the comments.

"A limitation here is the very small number of needle samples taken for biochemical analysis - only 2 needles for M2 and M3 - what were the numbers for others? Chlorophyll content can vary quite a lot between different cohorts of needles, so the resulting scatter plots are essentially extrapolations from 2 needles only. I'm not sure this is use-

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ful. Fig 2 shows this variability (in part) - although of course the fact is that the laser will return signals from multiple needles even for a single pulse. A 5 mm beam diameter is much larger than a single needle. What are the implications of this? There will also be significant multiple scattering and shadowing at needle scale. Using spectral ratios may average this effect out but it's still there. This means all results are a function of the spot size relative to the needle size. This issue ought to be discussed and quantified if possible, or at least discussed. Given the work is intended to look at small targets and the chemical analysis has been done on a very small sample of these, I think this needs investigation."

RESPONSE: The denotation "M2, M3" was inconsistent in the article; all the analysis was for one year old cohort (M2_1, M3_1). The needle samples were taken from all cohorts of sample branches with needles during time of sampling. The cohorts were also isolated from the lidar point cloud, which was difficult to do reliably. Most of the cohorts were either too small to be reliably distinguishable from the point cloud or, after new growth, shadowed by other parts of the tree. Several branches were sampled, but only these two were clearly visible, and since the new grown cohort (year 0, eg. M2_0) was not present during all of the measurements we only used year 1 cohorts. Additionally, only two needle pairs were taken from each cohort because we were worried that if we take too many needles each time, the point cloud would be eventually affected by the reducing amount of needles. The question about the spot size requires further research, but it mainly affects the intensity of the return signal and not the spectral content. And the effect of intensity is minimized by using spectral ratios. At this stage, single echoes have significant uncertainty, and meaningful results can only be achieved by averaging.

"One other question here is why use spectral ratios at all? These are purely empirical and no rationale is given as to why one or other might be used. What kind of results are we to expect? There are of course spectral models of needle reflectance properties which might be more appropriate to use in analysis like this eg the LIBERTY needle

model of Dawson et al."

RESPONSE: Spectral ratios are commonly used for estimating various parameters. They are simple, robust and easily implemented to our data. The purpose of this study is to show that useful information of the physiological state of the tree can be obtained by using this data. The advanced modelling techniques (eg. LIBERTY) are certainly interesting, but out of the scope of this study and a suitable topic for further papers.

"Minor points p15020 line19 - phenology is periodic anyway by definition i.e. it's not seasonal changes in phenology, it's just phenology. "

RESPONSE: Rephrased to "Plant phenology and seasonal chlorophyll content cycle are correlated to the CO_2 flux."

"p15021 l5: worth mentioning work of Asner here - has done a lot of this at large scale i.e. combining spectral and lidar. "

RESPONSE: Reference added.

"p15022 l15: why are these details approximate (scan resolution)? " RESPONSE: The scan resolution is approximate due to mechanical configuration of the scanner; each sweep is performed individually and the mirror is stopped after each sweep. At the beginning of the sweep the mirror is accelerating and at the end of the sweep it's decelerating, while the pulse rate remains constant. Therefore the pulse density is higher at the beginning and end of the sweep.

"Fig 1 - a scale would be useful, as would some indication of the accuracy of the co-registration. In addition, can the branches that are sampled be marked¿'

RESPONSE: Marked the branches M2, M3 to the figure and added information about tree height to the caption.

"Fig 3 - I'm not sure R2 values to 5 decimal places are useful. Also, can error bars be added to the scatter plots in fig 3-6?"

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RESPONSE: Reduced to 2 decimal values, added error bars to figure 6. The error bars are also visible figures 3-5 top row.

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