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# *Interactive comment on* "Retrieval of the photochemical reflectance index for assessing xanthophyll cycle activity: a comparison of near-surface optical sensors" *by* A. Harris et al.

**A. Harris et al.**

angela.harris@manchester.ac.uk

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Dear Reviewers,

Re: Manuscript entitled: "Retrieval of the photochemical reflectance index for assessing xanthophyll cycle activity: a comparison of near-surface optical sensors" A. Harris, J. Gamon, G. Z. Pastorello, and C. Wong

Many thanks for the helpful and constructive comments made regarding the manuscript. Below we address each of the comments from each of the reviewers in turn. We hope that the quality of the manuscript has been enhanced by the changes made and that the paper can be considered for publication in Biogeosciences.



A. Porcar-Castell (Referee #1)

A multitude of optical sensors and spectrometer systems are being rapidly deployed across flux sites. These sensors are expected to facilitate the interpretation of remotely sensed data and therefore the upscaling of processes such as photosynthesis. To reach this goal it is critical: i) that sensors remain stable on the long-term, or otherwise regularly calibrated and well characterized; and ii) that data obtained with different sensors and configurations can be intercompared. The photochemical reflectance Index (PRI) is an index that uses narrow spectral bands, normally centered at 531 and 570nm, to track the epoxidation status of the xanthophyll cycle pigments. The PRI should therefore be susceptible to slight changes in instrument properties such as band location or spectral resolution. In this study, Harris et al. compare the performance of two different systems to estimate diurnal variations in the PRI of different plant canopies: a widely used lower-cost multichannel sensor vs a more expensive spectrometer system, arranged in three different configurations. Their results show that both instruments were able to successfully track the adjustments in the PRI through the day, which in turn correlated with the diurnal changes in epoxidation status of the xanthophyll-cycle. Their study demonstrates that while data obtained from different instruments and setups was linearly correlated, differences in spectral response and sensor configuration had a significant effect on absolute PRI levels. Interestingly, the authors present a method that can be applied to correct data obtained with instruments with different spectral functions which was able to correct for most of the discrepancy.

The experiments were carefully planned, the article is clearly written and informative, and overall the paper is a significant, timely and useful contribution that will serve the community involved in optical measurements at flux sites. The article fits very well within the EUROSPEC Issue as it represents a perfect example of the sort of activities that EUROSPEC was set to do. Perhaps the only "weakness" was that the study did not go into the seasonal domain so the reader is left with some relevant questions: A) how these instruments would perform under seasonal (=large) fluctuations in temperature?

B) how different configuration and setups (e.g. SC or DC) would perform under more demanding environments, e.g. rain, snow, dust deposition, etc)? C) how would different sensors and spectral configurations succeed in tracking the slow seasonal changes in the de-epoxidation status of the xanthophyll-cycle pigments and its total pools? Obviously, answering these questions would have required a different experimental setup outside the scope of this paper. Perhaps a good topic for future work?

Response: Longer term seasonal experiments using near-surface sensors are the subject of forthcoming companion papers authored by Wong et al. (in press) and Gamon et al. (in preparation)

Specific comments:

1. Page 11922, 10. The authors write ". . .SKR 1800 sensors recorded a prominent decrease in the PRI during the early afternoon (Fig. 7). . . Consequently the observed between-sensor differences are likely due (to) each sensor having a slightly different IFOV". The authors could discuss the possibility that the higher spectral resolution of the SKR 1800 relative to the UniSpec system (as seen from Fig. 1) was actually outperforming the latter. Indeed, the diurnal PRI pattern from the Unispec in Fig 7 is rather flat despite the clear changes in illumination; in fact I would have expected some more variation. On the other hand, average PPFD appears to be higher at 13:00 compared to 14:00 when the sky was occasionally covered by clouds, consistent with the lower PRI at 13:00 relative to 14:00 obtained with the SKR 1800. Could the SKR 1800 be better at tracking diurnal changes?

Response: It is difficult to determine the exact cause of apparent sensor differences in the diurnal study because we are measuring over a rather heterogeneous canopy. Whether the SKR 1800 sensors are better at tracking diurnal changes is difficult to confirm but our initial dark-to-light experiments suggest that the SKR 1800 sensors may not respond as quickly to changes in EPS as the Unispec instrument. Even if the SKR 1800 sensors were more "sensitive" to changing diurnal conditions because of its



narrower FWHM, this was not reflected in a superior strength of the correlation with the EPS Skye sensors suggesting that other factors (e.g. S:N, FOV, etc.) may also come into play. Previous studies (e.g. Gamon et al.; 1992 and Filella et al.; 1996) have shown the Unispec to be able to detect diurnal changes in EPS. The lack of a clear diurnal signal from the Unispec in this study, in comparison to those observed by the SKR 1800 sensors, is thus likely to be because of the differences in the IFOV of the instruments. The patterns of EPS, and thus the PRI, vary quite markedly depending on whether the canopy is facing S or N (See figure 9). The fact that even when the SRFs of the SKR 1800 were simulated by the Unispec canopy instrument, the diurnal patterns still did not match suggests that differences in the spectral response of the instruments was not the reason for such differences in the diurnal response patterns. Further inter-comparison studies, which utilise more uniform vegetation canopies would help clarify the exact reasons for the observed sensor differences. To this end we have added a couple of additional paragraphs in the discussion section of the manuscript to highlight these issues namely: "Consequently the observed between-sensor differences are likely due to each sensor having a slightly different IFOV. The complexity of the conifer canopy is such that even relatively small differences in the IFOV between instruments may result in each instrument measuring parts of the canopy that may have been exposed to different levels of illumination (i.e. levels of sun and shade; Gamon and Bond 2013)" and . . ..."However, even when the SRFs of the SKR 1800 were simulated by the Unispec canopy instrument, the diurnal pattern did not match that of the SKR 1800 sensors and the PRI-EPS relationship was consistently stronger than the relationship observed between EPS and the SKR 1800-measured PRI suggesting that instrument differences other than the spectral response (e.g. signal-to-noise ratio, IFOV, the use of a cosine diffuser compared to a Spectralon panel) may also have contributed to the observed divergence in diurnal PRI values between instruments. Further inter-comparison studies, which utilise more uniform vegetation canopies (e.g. Anderson et al. 2013) would help clarify the exact reasons for these observed sensor differences."

2. In view of the impact that minor changes in sensor spectral configuration have on

the resulting PRI levels, how would the authors suggest/recommend to deal with sensor heterogeneity and intercomparability of results? For example, if we have data from a network of 10 flux sites each equipped with a slightly different SKR 1800 sensor, how would the authors suggest to compare the PRIs based on their findings? Should one apply their deconvultion method? use some scaled measure of PRI? I believe this is an interesting point that the authors are well in place to discuss in the Concluding Remarks.

Response: We have added an additional section to the first paragraph in the Concluding Remarks section to address this issue, namely "... a full characterisation of these sensors is necessary if the data are to be compared across geographical locations, over time and between instruments. Specifically, it is critical that the SKR 1800 sensors being used have matching wavelengths and the same spectral response. Ideally, this could be confirmed by the manufacturer or by independent laboratory tests. If independent, automated spectrometers were also on site, then it would be possible to use convolution to understand the sources of any differences that might occur. All sensors deployed should be mounted at similar distances from the canopy and at similar angles. They should be checked and cleaned annually and according to the manufacturer's recommendations, returned for laboratory calibration every two years. Additional corrections, for dark-current drift and temperature drift in response to large variations in temperature, may also be required (Eklundh et al. 2011)."

Minor Corrections:

1. The authors use the FWHM provided by the manufacturer to perform the spectral deconvolution and compare the result with the SKR 1800 PRI. Was the manufacturers FWHM provided for different wavelengths or for a single wavelenght? how much can FWHM be expected to vary across wavelengths (525-570 range)? Could that have an impact on the deconvultion process?

Response: We used the spectral response curves for the SKR 1800 that were provided



by the manufacturer, and these were slightly different for each sensor and wavelength as indicate in Figure 1. Individual response curves were used to simulate each of the two PRI bands from the Unispec data. As we mention in the manuscript, we did not take into account that the filters for the upward facing sensors were not exactly the same as the filters used for the downward facing sensors for the equivalent PRI band. The differences in the spectral response functions were not substantial, but this may have had an impact on the simulated reflectance values. The individual spectral response curves for the SKR 1800 and Unispec DC instrument are presented in Figure 1.

2. Section 2.3.1. "Dark-to-light transition experiments were performed over *five* different plant canopies. . ." I believe it is *four*, the fifth being for the diurnal study?

Response: Yes, we have corrected this in the text

3. Section 2.3.2. 10-15, ". . .were also sampled (2x3 cm) and immediately. . .". Please specify, 2x3 cm of what? total needle area? did you produce a mat of needles and then cut out a 2x3 square?

Response: For each plant, we sampled 2 needles, each 3 cm long, and have changed the wording accordingly

4. Section 2.3.2. Please give at least some minor details on the temperature and relative humidity measurements

Response: We already provide some written detail on the meteorological conditions and a figure graphically depicting the diurnal meteorological trends in the results section i.e. section 3.2. We have moved the order of the sentences and added an additional sentence, which refers to relative humidity levels i.e. "Fig. 6 illustrates the environmental conditions present during the diurnal experiment undertaken over a lodgepole pine canopy during July 2013. Sky conditions were clear throughout the morning although some clouds were present at noon and became more frequent from 16:00 onwards (Fig. 6a). Temperatures throughout the measurement period ranged from

13°C at sunrise to a maximum of at 24°C at 17:08 (Fig.6c) whereas relative humidity was highest during the early part of the day (60-70%) and lowest during early to mid-afternoon (∼ 45%; Fig. 6d)." Seeing as though this information is already provided in the results section, we choose not to duplicate this text in the methodology section i.e. 2.3.2.

5. Section 3.2.1. 15, ". . .after the SRF correction had been applied to both (add: UniSpec) instruments"

Response: Change made

6. Pag 11924. 25. Although one can draw conclusions on the seasonal scale, the article by Gamon and Berry deals with the spatial component of the PRI variability rather than the temporal. The authors may consider adding a reference to a seasonal study that supports their statement e.g. Stylinsky et al. 2002, Filella et al. 2009, or Porcar-Castell et al. 2012

Response: We have included the following references "Stylinski et al. 2002; Garrity et al. 2011; Porcar-Castell et al. 2013; Wong and Gamon in press"

Anonymous Referee #2

This is an interesting study on a key topic. For the last years different initiatives (Spec-Net, EUROSPEC, OPTIMISE) have worked on the integration and standardization of in situ optical sampling. However, the wide range of sensors commercially available, both multi and hyper-spectral, makes it difficult to achieve comparable data unless an appropriate characterization of sensor features and measurement protocols are implemented. This study clearly contributes to this research field as it compares two instruments, able to measure the narrow bands required to calculate PRI and commonly used in field spectroscopy to long term in situ vegetation monitoring. The research questions addressed are very relevant and clearly fall within the scope of Biogeosciences.



The manuscript is clear and well written. Abstract and introduction are concise and properly summarize relevant research to provide context. Regarding methods and results, authors clearly identify and describe the procedures followed and the results obtained and they order them in a meaningful way. However I would recommend including a more complete description of some specific analysis as is the case for the method used to convolve the Unispec spectra in order to make it comparable with the SKR data. Additional information is needed in order to explain how the spectra acquired with an instrument having larger FWHM are transformed to one of higher spectral resolution. This will allow their reproduction by fellow scientist.

Response: We have added some additional information to the end of section 2.2.4 i.e. "As the SKR 1800 sensor only contains two wavebands we used the Unispec (1 nm interpolated spectral data) to simulate each of the bands separately using the method outlined by Robinson and MacArthur (2011) so that the output value for each band is the integral of the product of the SKR 1800 SRF and the Unispec input spectrum. All calculations were implemented in the R statistical environment (R Development Core Team, 2012)." We would like to re-iterate that we are using this approach simply as an investigative tool to determine possible causes of the wide differences in the values derived from the two instruments, as noted in the text.

Finally, in the discussion section, authors include an interesting analysis on the differences found between PRI measured from different instruments and also on the correlation between PRI and EPS at leaf and canopy scales. However, throughout the manuscript, and specifically in this section, the discussion on the instrumental differences between the two sensors is focused on the SRFs. Other technical differences (FOV, cosine response, etc) and their potential role on the discrepancies found in PRI measurements should be further discussed here as, in my opinion, the comparison between sensors is one of the most important contributions of the paper.

Response: We believe we have addressed these concerns in response to a comment made by reviewer 1, namely in the discussion section by adding a paragraph on issues relating to the FOV of the instruments "The complexity of the conifer canopy is such that even relatively small differences in the FOV between instruments may result in each instrument measuring parts of the canopy that may have been exposed to different levels of illumination (i.e. levels of sun and shade; Gamon and Bond 2013)" and the possibility of other extraneous factors influencing the direct comparison of the instruments.. "..., even when the SRFs of the SKR 1800 were simulated by the Unispec canopy instrument, the diurnal pattern did not match that of the SKR 1800 sensors and the PRI-EPS relationship was consistently stronger than the relationship observed between EPS and the SKR 1800-measured PRI suggesting that instrument differences other than the spectral response (e.g. signal-to-noise ratio, FOV, the use of a cosine diffuser compared to a Spectralon panel) may also have contributed to the observed divergence in diurnal PRI values between instruments. Further inter-comparison studies, which utilise more uniform vegetation canopies (e.g. Anderson et al. 2013) would help clarify the exact reasons for these observed sensor differences.".

Specific comments:

Abstract

1. Authors references to lower cost vs expensive instruments should be clarified in the abstract and all through the text. Cost is related to sensor characteristics (multispectral versus hyperspectral sensors) and this should be clarified in the text, otherwise it can cause confusion.

Response: In the abstract we have adjusted the text so that the following lines read "This interest has facilitated the production of a new range of lower-cost multispectral sensors specifically designed to measure temporal changes in the PRI signal." and "We compare the results with those obtained using a more expensive industry-standard visible to near-infrared hyperspectral spectrometer (PP-systems UniSpec) and determine the radiometric compatibility of measurements made by the different instruments." We also clarify this distinction in section 2.1 Instruments i.e. "The instruments were chosen



to facilitate a comparison of the results obtained from a commonly used commercially available lower-cost two-band sensor specifically designed for field deployment and continuous in situ monitoring, with those obtained from more expensive hyperspectral industry-standard instruments that are field-portable but not specifically designed to be deployed unattended in the field without further hardening (e.g. Hilker et al. 2011)."

2. Authors affirm that their results illustrate that "small differences in instrument configuration can have a large impact on the PRI measurements". But, can the differences between the two compared instruments be considered small?

Response: In terms of the centre wavelengths used to calculate the PRI the differences would "appear" to be small i.e. 531 nm and 570 nm for the Unispec and 531 nm (down) 530 nm (up) and 567 nm (down) and 569 nm (up) for the SKR 1800. However, we agree that differences in the FWHM and shape of the spectral response curve are not necessarily "small". We now clarify this in the manuscript by rewording this sentence so that it now reads " ....., illustrating that differences in instrument configuration (e.g. spectral response functions and band positions) can have a large impact on the PRI measurement values obtained."

3. Correlation values obtained from the Unispec (and not only for the SKR 1800) should be also included in the abstract.

Response: The wording has been changed to "Despite differences in absolute PRI values, significant correlations were observed between the canopy PRI derived from both the SKR 1800 and the Unispec instruments, and the epoxidation state of the xanthophyll cycle ($r2 = 0.46$ $p < 0.05$ and $r2 = 0.76$ $p < 0.01$; respectively).

Methods

4. Table 1 should include more information on technical characteristics of the instruments compared: operating temperature range, radiometric resolution, sampling interval, etc, in order to make it fully informative on the differences between them.

Response: We have added to additional columns to table 1, namely “Sampling Interval” and “Operating temperature” and completed these columns to the best of our ability based on the information provided by the manufacturer.

5. The use of four different instruments (1 SKR 1800, 1 Unispec DC and 2 different Unispec SC should be clarified in section 2.2.2.

Response: We clarify this by adding the following sentence to the end of section 2.1 “The DC instrument was used to facilitate the collection of rapid continuous reflectance measurements during dark-to-light experiments, whereas the two SC instruments were used to obtain simultaneous canopy and leaf-level reflectance measurements during the diurnal experiment.”

6. In table 1, I suggest to replace operating range by Wavelength range

Response: Change has been made

7. If possible change (Jin and Eklundh, 2013) in page 11910 line 20 for other reference that can be more widely accessible.

Response: At present this is the only reference which clearly documents this type of calibration method.

8. The spectralon targets used with Unispec DC and SC and Skye SKR where all calibrated panels? Please specify.

Response: The Spectralon targets were calibrated although this was not a recent calibration. All panels were handled with care and regularly cleaned, however, there is likely to be some degradation (in the order of <3%) to the panels since their original calibration. The same panel was used for each set of Unispec measurements within any given experiment (e.g. dark-to-light and diurnal) thus all the PRI measurements are at least relative to one another. We do not compare data across experiments i.e. between experiments that utilise different Spectralon panels.



9. In page 11913 line 11 authors state that the area viewed by each instrument was approx. 20 cm in diameter. Was a FOV characterization of the instruments performed in order to confirm the area viewed by each of them or was this area calculated relying on manufacturer specifications? Unless few researchers have acknowledged that it is necessary to characterize the FOV of a spectroradiometer, some authors have demonstrate that these may have great variability which, in this case, can affect the comparison, especially when the target is heterogeneous as is the case for most vegetation covers.

Response: We did not characterise the SKR 1800 FOV ourselves but instead we relied on the manufacturer specifications in terms of defining the FOV of each sensor head. We have added some information to Table 1 regarding preliminary in-house investigations into the FOV of the Unispec using fibre optics and a Hyper Tube manual restrictor. We agree that all parts of the ground resolution element sampled may not be equally represented in our measurements. In Section 4 we do discuss that issues relating to the positioning of the sensors and the defined FOVs may also have led to some of the differences noted between the two instruments.

10. Why different time intervals (1 and 15 min) were used for SKR and UniSpec measurements during the diurnal experiment?

Response: Two different timing intervals were used as the SKR 1800 was set to continuously monitor and log measurements but we were using a SC UniSpec, which meant that we had to take a white panel reading before each spectral reading. Seeing as though the experiment lasted for over 13 hours, we thought that a practical solution would be to collect measurements from the UniSpec every 15 minutes. Since the text states that the SC sensor was used in the diurnal study and how the SC measurements were collected, we have chosen not to add any additional information to the manuscript at this point.

11. Figure 7: It is not easy to visually discriminate between Unispec SC leaf, canopy

and SKR 1800 cross-calibration lines. The same for Unispec 531 and 570 HCRF in figure 8.

Response: Figure 7 and Figure 8 have been adjusted and now include colour to help discrimination of different instruments and channels.

12. In figure 9. PRI values are those measured with the Unispec SC instrument at the canopy level? Please clarify in the figure caption.

Response: The caption already states that these data were collected at the leaf-level i.e. "Fig. 9 Diurnal course of lodegepole pine (Pinus contorta) leaf-level photochemical reflectance index (PRI) and the epoxidation state of the xanthophyll cycle components (EPS). PRI values for each of the four directions are means of 10 sampled spectra. Error bars represent $\pm$ 1 SEM." No further changes have been made

Discussion and concluding remarks

13. Regarding the statement in page 11921 lines 21-27, it would be interesting to include in the text the correlations found for the leaves sampled from plants facing south in comparison to the main values analyzed in figure 10.

Response: We have added the requested values. The paragraph now reads "The strength of the relationship between PRI and EPS measured at the leaf-level was weaker than that measured at the canopy-scale using a similar UniSpec instrument. Diurnal PRI patterns at the leaf-level were largely dominated by leaves sampled from plants facing south, but also included measurements from leaves exposed to lower levels of illumination where diurnal changes in EPS and PRI were minimal (Fig. 9). Consequently relationships between leaf-level PRI and EPS were stronger for south facing leaves ($r2 = 0.73$, $p < 0.05$ and $r2 = 0.43$, $p < 0.05$; for the SW and SE facing leaves respectively) than those facing north ($r2 = 0.07$, $p = 0.5$ and $r2 = 0.12$, $p = 0.4$; for the NW and NE facing leaves respectively)."

14. In page 11923 authors state that a "full characterization of these sensors is nec-



essary if the data are to be compared across geographical locations, over time and between instruments". I fully agree with this statement but, in view of the results obtained, authors should be more specific about recommendations on how to approach this characterization and which instrumental factors should be analyzed, especially in the context of the outdoors unattended systems explored in this paper as they can face wide ranges of environmental conditions in terms of temperature, irradiance or sun height among others.

Response: Reviewer 1 has made a similar suggestion and we have responded to both comments by including some additional text in the first paragraph of the concluding remarks section; namely ". . . a full characterisation of these sensors is necessary if the data are to be compared across geographical locations, over time and between instruments. Specifically, it is critical that the SKR 1800 sensors being used have matching wavelengths and the same spectral response. Ideally, this could be confirmed by the manufacturer or by independent laboratory tests. If independent, automated spectrometers were also on site, then it would be possible to use convolution to understand the sources of any differences that might occur. All sensors deployed should be mounted at similar distances from the canopy and at similar angles. They should be checked and cleaned annually and according the manufacturers recommendations, returned for laboratory calibration every two years. Additional corrections, for dark-current drift and temperature drift in response to large variations in temperature, may also be required (Eklundh et al. 2011). Regular cross-calibration can be used to assess and possibly correct for such instrument drift."

15. Page 11919 lines 9-11. Review sentence. R2 values correspond to leaf and canopy respectively and not canopy and leaf as stated?

Response: Corrected

Anonymous Referee #3

General comments:

In this study two different instruments for spectral measurements the Skye SKR1800 and the PP-systems UniSpec. The final goal of the study is to recommend strategies for the effective use and comparison of data from both sensors. The topic is pertinent with the scope of the journal. The interest in continuous monitoring of ecosystems through unattended sensors increased largely in the last years raising a need for the standardization and comparison of measurements. This study can be an important contribution in this area. The experiment was well planned and executed. The manuscript is well written. Methods and results are correctly described. The Discussion needs an improvement for clarity. I would suggest to split the text into specific paragraphs.

Response: The discussion section is already split into paragraphs. We have no control over the formatting of those paragraphs as this is defined by the manuscript template.

Specific comments:

1. Page 11917 line 1-5 and figure 5. The larger fluctuation in the PRI response is more evident in the Unispec than in the SKR1800 in the Aspen. Any comment on this?

Response: We have added an additional line to the first paragraph in section 3.1.2, which reads "Slight differences in the FOV of the two sensors over the aspen canopy may have led to the more evident fluctuations in PRI measured by the UniSpec than measured by the SKR 1800 sensors".

2. Page 11919 line 5 and fig. 10 The figure 10 shows linear regression between EPS and PRI derived from the SKR1800 and the UnisSpec canopy and leaf measurements. It would of major interest to estimate the regression, not only evaluate the correlation coefficients. A comparison of the slopes would be of great benefit to the knowledge on the relative sensitivity of the sensors to physiological changes (expressed by EPS) and facilitate the comparison between instruments. In addition, potential differences in the regression line are mentioned in the discussion to explain differences between leaf and canopy measurements (page 11921 line 29).



Response: We have added the estimated regressions to figure 10

Technical details:

3. Page 11913 2.2 Experimental set-up. Further details on leaf measurements would be desirable.

Response: The leaf methods are described in section 2.2.2. (leaf reflectance) and section 2.3.2 (pigments).

4. Page 11913 2.3.1 line 24 details on plants age and size are lacking.

Response: We have added the following additional information "The strawberry plants were cultivated in a large (2 x 2 m) flat crate. The pine and aspen saplings were approximately 4 and 3 years old; respectively (approx. 1 m and 1.5 m in height; respectively). Both species were grown in large pots (6.23 L) using a 1:2 mix of sandy loam and commercial potting soil (Sunshine Mix 4, Sun Gro Horticulture, Agawam, MA, USA) supplemented with slow release fertilizer (Nutricote 14-14-14, Sun Gro Horticulture, Agawam, MA, USA), and arranged in a wooden crate (1 x 1 m) to simulate a dense seedling monoculture stand. The alfalfa (Medicago sativa) was grown as a perennial crop on the university South Campus farm (Edmonton, Alberta) and was approximately 0.4 m high at the time measurements were collected. "

5. Page 11914 line 1 and following. It is unclear how the excess of irradiation could mask the effects of canopy structure in the short term.

Response: Unfortunately we are not sure what point the reviewer is referring to here and so we are unable to provide a full response to this comment. However, if the comment is related to an issue associated with the ability to detect leaf-level signals at the canopy scale, then this study and others (e.g. Gamon and Qiu 1999) demonstrate that for a closed canopy stand, such as those used in this study, parallel leaf and stand level responses to irradiation can clearly be observed.

6. Page 11915 line 6. Again few indications on the size and density of trees would

be desirable. “closed-canopy stand” . The term stand is used in forestry to indicate a community of trees in the field, it cannot be applied to potted trees.

Response: We have changed the wording to “closed-canopy synthetic stand (1 x 1 m plot)”

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