Cover Letter

Response of the authors to the reviewer's comments

Manuscript: Transmissivity of solar radiation within a Picea sitchensis stand under various sky conditions

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The authors would like to thank the referees for their valuable remarks, constructive comments, and careful corrections which helped to increase the overall quality of the manuscript.

All changes are marked in bold red throughout the revised manuscript.

Anonymous Referee #3

Dengel et al. describe a study on light extinction in a managed Picea sitchensis stand in Central Scotland, addressing changes in the spectral distribution of light, which has a potential impact on photosynthesis. They present a comprehensive set of measurements quantifying the horizontal and vertical variations in spectral distribution, and focus on the role that sky conditions play in determining this distribution.

Overall, the study is concise and clearly written, and the topic is relevant for publication in Biogeosciences. Relatively few data sets exist that discuss spectral changes both horizontally and vertically, and I consider this paper suitable for publications once a few remarks have been addressed.

Reviewer # 3 detailed comments	Response	Author's reasoning , comments
Major comments: - p. 3828, l. 8: Here, three objectives of the study are listed, but for (b) and (c), it is unclear how "importance" is defined: The authors do not measure the importance for photosynthesis in the study. Rather, the study determines whether spectral differences exist (b), and how gaps affect the spectral distribution (c).	Dealt with	We have reformulated our research questions and hope to have dealt with them in the appropriate manner and extend.
- The discussions paper addresses light distributions in great detail, but does not show the impact of these changes on photosynthesis from measurements. This is not a flaw as such, but the authors seem to try and compensate for that by adding Fig. 7 in the last sentence of the paper, which comes a bit out of the blue. Also, the figure is referred to as "taken from Dengel and Grace, 2010" (p. 3839, l. 25), but, although the data	Dealt with	We believe it does improve the overall quality of the manuscript as it does the deliver a "big picture" visualisation showing how CO2 exchange of Sitka spruce is influenced by a change in sky conditions using eight consecutive days as an example, including overcast, cloudy and 4 consecutive clear days. Unfortunately the original data measured on those days in Griffin are rather gappy and do not really contribute to the "big picture" intended with this section.

probably originate from there, the figure as such is not given in there. If the authors want to address the impact of sky conditions on photosynthesis, I think this figure should be placed in the results section and should be described and discussed properly, and the measurements for this should be described (briefly) in the methods section (with reference to Dengel and Grace, 2010).		The advice given has been followed up and additional information added to the method, results and discussion section.
- p. 3833, l. 20: The extinction plot in Fig. 4, used to determine Beer-Lambert extinction coefficients, is interesting, but I have some doubts about the discussion of the clear sky curve. The light extinction as described by Beer-Lambert law should be considered a canopy-integrated description representative for a somewhat larger area, where beams of light can get absorbed in the canopy at different heights (depending on the LAI distribution). Determining the extinction coefficients from the observations in this study works reasonably well for conditions with diffuse light only, because of the absence of a direct beam. However, for the clear sky case, the beam is intercepted relatively high up in the canopy, after which there is no direct radiation left (except for the observed sun fleck at app. 11 m height). The slope in Fig. 4 observed for the remainder of the curve is hence representative for the diffuse fraction of the radiation occurring on a clear sky day. This binary behaviour for an individual measurement is not captured by Beer-Lambert's law, but when integrated over a larger area (where interception can happen at any height, and some beams can penetrate deeper), it still holds. Hence, the extinction coefficient could be determined properly only if a larger set of measurements would exist.		We do agree. Strictly, Beer-Lambert's law is only applicable to a homogenous medium such as a solution of chlorophyll, but it has been applied to canopies since the 1960s (from Monsi and Saeki onwards). Yes, it works better for diffuse light because all beam-angles are represented fairly equally, unlike direct radiation when sunlight comes from more or less one direction and it can sometimes shine through a single gap onto the sensor. Further data integrating spatially and temporally would of course reduce the uncertainty in our estimated k-value. We acknowledge this weakness, and we do discuss it.
Minor comments and technical corrections: - p. 3826, l. 7: replace "an" with "a"	Dealt with	This has been now corrected.
- p. 3827, l. 26: It is unclear what "this" refers to, I presume it is the occurrence of sunflecks?	Dealt with	We mean the response to sunflecks as in saturation of photosynthesis or possibly photo-inhibition. This has been now added to the sentence

- p. 3828, l. 9: Please add the unit to LAI for consistency (you do so in l. 23).	Dealt with	This has now been corrected, also in the abstract.
- p. 3828, l. 23: Replace "are" with "were"	Dealt with	This has now been corrected.
- p. 3829, l. 10/19: "All spectral measurements": How many measurements were performed, and how were these distributed over clear days, cloudy days and overcast days?	Dealt with	Please see above for number days and measurements per data point. As stated before there are one day per sky condition. Please see above explanation as the reasoning to use such a limited number of data. There are 23 measurement point along the tower and 47 along the forest floor.
- p. 3829, l. 23: Please add that the normalization was done relative to the above canopy measurement.	Dealt with	No. The normalisation has been done by applying the standard method (Normalised data = (x-min(x))/(max(x)-min(x)), which is a standard procedure. If we would have used the above canopy values we would have estimated the transmissivity, which is shown in Fig 3 (now Fig 4). We have now included this equation as well to avoid any further confusion.
- p. 3830, Eq. 1: You use E rather than E in Eq. 2, it would be more correct to do so here as well.	Dealt with	Equation 2 (now 3) has been modified accordingly.
- p. 3832, l. 1: I am unsure what "frame" refers to here. Do you mean within the same period?	Dealt with	We mean those measurements that are part of the current study. (TRAC measurements were carried out throughout the year). This sentence has been modified to appear clearer.
- Fig. 2: It is unclear to me why panel (c) is displayed. I guess the top of panel (d) should resemble (a) (and the bottom of (d) should resemble (b))? If right, panel (c) is not necessary.	Dealt with	This figure has been modified and the c panel removed. In order to clarify this we have added another figure which is now figure 2.
- p. 3832, l. 24: The term "shifts" is somewhat misleading here: There is not more infrared radiation - rather, there is less absorption in this band than in the others, which makes the infrared relatively more important. Energy is not shifting from one wavelength to another.	Dealt with	We agree. We have changed the wording of this sentence to read better now.
- Fig. 3: Are the clear/cloudy/overcast measurements shown here all one-day measurements? And do more measurements exist? In the latter case, it may be interesting to show how these curves vary between days with comparable sky conditions.	Dealt with	Unfortunately yes. The probability that measurements can be taken again in exact same location (time and space) under exact the same solar radiation intensity is rather small. Therefore we limited the data used in the current study to show a snapshot of these conditions and a difference in PAR of approx. 600 umol/m2/s between clear and cloudy and cloudy and overcast. We have added an explanation in the main manuscript

		mentioning this reasoning. In order to carry out all these measurements we had to use six instruments (2x GER, 2 laptops, the TRAC instruments and the camera for the sky) with often at least one failing half way through the measurements and were rather unlucky. Also the weather conditions did not allow us to carry out the measurements as the location is 160km from the home institute away and three people involved when carrying out the measurements.
- p. 3834, l. 2: If lateral illumination occurs, as the authors suggest, it should be visible in the PPFD near the surface as well. This seems to be the case for clear sky, but the scale of Fig 3b does not allow to determine this for the other conditions.	Dealt with	Unfortunately this is only seen clearly in the clear sky conditions. We have added an insert in Fig 3 (now Fig 4) to highlight this.
- p. 3835, l. 2: "...closely resembling the "background" values shown in Fig. 6a, although 50% higher.": Would it be possible to plot the background (diffuse) part from Fig. 6a also in Fig. 6b to illustrate this?		Unfortunately this is not possible without having to interpolate the data to a fixed number of measurement points in each transect sector. The TRAC instrument does measure continuously at 32 Hz so that there are not exact same number of data points in each sector. We believe Fig 6b and 6a are clear enough to show the different diffuse values and that (b) is much higher. Both diffuse values show the thinning pattern.
- p. 3837, l. 17: check the spelling of "branches" - p. 3838, l. 17: replace "which" with "with" - p. 3839, l. 15: Closing brackets are missing	Dealt with	All these typos have been corrected.