

## **Response to reviewers' comments**

*We would like first of all, to express our gratitude to the editor and reviewers for their patience, constructive criticisms and suggestions to improve this paper. We have carefully considered them all and have responded to each of them.*

## **Relevant changes made to manuscript**

No major changes have been made at this stage as only minor corrections were requested by the reviewers.

**Interactive comment on “Assessing the spatial variability in peak season CO<sub>2</sub> exchange characteristics across the Arctic tundra using a light response curve parameterization” by H. N. Mbufong et al.**

**Reviewer #1 comments**

**C: Comment; R: Response**

**C:** The title of the Mbufong et al. manuscript ” Assessing the spatial variability in peak season CO<sub>2</sub> exchange characteristics across the Arctic tundra using a light response curve parameterization” tells exactly what the manuscript is all about. All in all it is a very nice manuscript and a good example of collaboration of many researchers from many countries and research institutes. There are interesting findings in the paper and it gives a nice overview of the highest component fluxes during the summer in the Arctic.

**R:** We thank this anonymous reviewer for the patience and helpful insights into this manuscript. Your comments and suggestions have been very important in bringing the manuscript to fruition. Thank you too for your kind words.

**Technical notes:**

**C:** page 6421, line 2: “Functional variability”, what does it mean in the context of the manuscript?

**R:** We have taken out the “functional” so as to avoid any misinterpretation. The idea was to introduce that we are investigating relationships between CO<sub>2</sub> and environmental variables using mathematical functions. I thank you for this.

**C:** 6421, 21: “Thus, indicating. . .” I think this sentence is missing a verb.

**R:** The sentence has been rephrased.

**C:** 6422, 25 – 6423, 2: This is a very long sentence, please shorten.

**R:** Sentence has been shortened.

**C:** 6423, 21: “. . .that light is not limiting. . .” You mean lack of light?

**R:** We mean the abundance of light. Unlike during the winter in the tundra when light is a limiting factor to plant growth.

C: 6423, 28: “. . .the best approach. . .” be more specific, e.g.: “. . .the best approach associated with EC. . .”

**R: We thank you for this clarification. Sentence has been updated accordingly.**

C: 6429, 26: There are two numbers and three respective parameters.

**R: 32 to 35% is written here as a range because temperature explained 32% of  $F_{csat}$ , 32% of  $P_{sat}$  and 35% of  $F_{c1000}$ . We have also deleted the respectively at the end of the sentence.**

C: 6431, 17-21: First you write about relative variability, and based on that you make suggestion to the absolute variability. The logic is broken here.

**R: We have rephrased the latter sentence so we focus on relative variability.  $R_d$  is more variable suggesting that it drives the total  $CO_2$  flux variability more than the assimilation parameters ( $F_{csat}$ ,  $P_{sat}$  and  $F_{c1000}$ ) do. Thank you for this.**

C: 6432, 14: “construction of plant stems. . .” – For my background “growth of stems, leaves and roots” would be faster to understand, but perhaps construction is all right as well.

**R: “construction” has been changed to “growth”.**

C: 6432, 27: “temperature was > 1 stdev above the mean” Perhaps this could be written more clearly?

**R: Thank you for this. The sentence has been rephrased to make it clearer.**

C: 6433, 15: “These are higher than estimated in our study because. . .” Are you sure that this is the reason? If so, please explain why.

**R: The more northerly location of our sites and the associated lower temperatures compared to the sites in Frohking et al, 1998 could explain why the respiration rates at our sites are lower than estimates from Frohking’s study. This has been incorporated in the manuscript. Thank you for pointing this out.**

**C:** 6433, 25: “. . .correctly simulate. . .” There is no ‘correct’ / ‘incorrect’ (or maybe everything is ‘incorrect’. It’s better to say that some simulation methods can be better justified (and better) than others.

**R:** Thank you for this very important point. “Correctly” has substituted with “better”.

**Interactive comment on “Assessing the spatial variability in peak season CO<sub>2</sub> exchange characteristics across the Arctic tundra using a light response curve parameterization” by H. N. Mbufong et al.**

**Reviewer #2 comments**

**C: Comment; R: Response**

**C:** Mbufong et al. have successfully addressed all the major revisions needed in the previous submitted version of the manuscript. However, the author should also consider the following minor revisions before get the manuscript ready for publication.

**R:** We are grateful to you for the thorough examination and constructive criticisms to this manuscript. Your valuable insights have gone a long way to bring this manuscript to completion.

**Technical notes:**

**C:** Lines 27-28: please specify when data have been collected.

**R:** The years and season has been inserted in the abstract.

**C:** Line 45: replace “modern” with “actual”.

**R:** modern has been replaced with actual.

**C:** Line 46: add “collected “ after data.

**R:** collected has been added.

**C:** Line 48: which question?

**R:** Lines 44 to 46 introduces the question as to how carbon stocks are renewed by presently growing vegetation, and whether actual C sequestration rates vary among arctic tundra ecosystems and vegetation types.

C: Lines 49-50: why tundra ecosystems are unique ecosystem for climate change? Please specify it.

**R: This sentence has been improved to include the permafrost uniqueness of the Arctic tundra. Thank you for this.**

C: Lines 62-66: this sentence is too long and difficult to follow; please split it in two.

**R: this sentence has been shortened following the suggestions of reviewer 1.**

C: Lines 67-70: this sentence is unclear; try to rephrase it and add some references to support it.

**R: This sentence has been shortened and a reference to Laurila et al (2001) has been added.**

C: Line 70: add “index” after “leaf area”.

**R: index has been added.**

C: Line 93: please define the acronym “LRC”.

**R: LRC has been defined (light response curve).**

C: Line 95: please define here the acronym “NDVI” (which is defined later in line 184).

**R: NDVI has been defined (normalized difference vegetation index).**

C: Line 96; remove “and”;

**R: “and” has been removed.**

C: Line 104: I would replace “range” with “type”.

**R: This has not been changed as we list the range of tundra types. Thanks for the suggestion.**

C: Line 132: remove “the”.

**R: “the” has been removed.**

Line 161: the sentence starts with “these parameters”, but which ones?

**R: “These parameters” has been changed to “the LRC parameters”.**

C: Line 166: please rephrase to avoid repetitions.

**R: This sentence has been rephrased.**

C: Line 182: it is written ”were also used”, but to do what?

**R: This phrase has been replaced with “were also examined for significant relationships with LRC parameters”.**

C: Line 185: since the manuscript investigates many study sites, to what refers “the dominant wind direction”?

**R: This refers to the dominant / prevailing wind direction in each study site.**

C: Lines 206-208: what is written is quite obvious: is there any other (more) scientific reason?

**R: LAI is also an indication of the photosynthetic capacity as larger leaf area would mean more stomata and more carbon assimilation. Integrated at the ecosystem scale (e.g. in eddy covariance studies), this would mean an overall stronger carbon sink.**

C: Lines 227-230: The author should also consider that photosynthetic CO<sub>2</sub> depends on Ribulose 1,5 biphosphate (Rubisco) enzymatic activity which has a variable optimum depending on plant species and growing conditions. Is there any reference of Rubisco activity specifically measured in tundra’s vegetation?

Moreover, the author should consider that the physiological process of “photorespiration”, compete (in light conditions) with Rubisco activity and therefore decrease the efficiency of the CO<sub>2</sub> photosynthetic assimilation (Laisk and Loreto, 1996). This can help the author to explain the variability found.

**R: We agree that photosynthetic CO<sub>2</sub> also depends on rubisco capacity. This is largely dependent on plant species and growing condition. In RU-Seid-SA, Kiepe et al (2013) showed that 68% of the carbon assimilation of the dominant plant species was rubisco limited while 32% was light limited. With the variability in rubisco capacity of the heterogeneous Arctic plant species affecting the total ecosystem rubisco capacity, it is unclear what impact this will have on the photosynthetic capacity of the Arctic tundra. We have inserted appropriately a sentence describing this point while referring to Kiepe et al (2013).**

**We also agree that in the light there is the simultaneous process of photosynthesis and photorespiration counteracting one another while the rubisco activity further weakens the photosynthetic capacity of the ecosystem. We have not examined rubisco capacity as a potential driver of LRC parameters in this study as this data was not readily available for all study sites.**

**Thank you very much for bringing up this very important point.**

**C: Line 244-245: both Centritto et al (2011) and Ow et al. (2008a,b) run experiments at “leaf-” and not at “ecosystem” level (as it is written here).**

**R: We have included leaf alongside ecosystem respiration to clear this up.**

**C: Line 250; with “ecosystems are diverse” does the author meant “ecosystem biodiversity”?**

**R: This encompass both biological (biotic) and environmental (abiotic) diversity.**

**C: Line 254: the author should make the point that whereas NEE is measured, Rd is just mathematically calculated.**

**R: A sentence has been added to this effect.**

**C: Line 273: please rephrase “our study is circumpolar”.**

**R: “circumpolar” has been deleted from the sentence.**

**C: Line 277: replace “during” with “through”.**

**R: “during” has been replaced with “through”. Thank you for this.**



**C:** Line 278: ...and not only! See my comment above about photorespiration.

**R:** We have included the rubisco capacity as a potential driver of fluxes under light conditions.

**C:** Lines 309-311: what are the “fen values”? Please rephrase it.

**R:** Sentence has been rephrased.

**C:** Lines 338-339: again, please consider also the photorespiration process (see comments above).

**R:** We have inserted the rubisco capacity as a potential driver of CO<sub>2</sub> fluxes in the Arctic tundra

**C:** Lines 342-343: I suggest to remove this sentence as it is redundant.

**R:** There were no trends over the entire Arctic tundra yet there were differences between sites in some sub regions. This brings up the issue as to the absence of any temperature and latitudinal patterns in the entirety of the study while the following sentence attempts to explain the difference within sub region as related more to ecosystem type than to climate. It is our opinion that the latter sentence would make no sense without the former. So I have left the last 2 sentences as they were. Thank you for this suggestion.

**C:** Line 344: I would replace “however, these differences” with simply “although”.

**R:** This has not been changed (see previous comment). Thank you again for the suggestion.

**C:** I would reverse Table A1 with Table A2. - Figure caption should not explain, but just describe the figures (i.e. Fig. B4, Fig. 6).

**R:** Table A1 and A2 have been swapped and figure captions (Fig. B4 and Fig. 6) have been edited. Thank you very much for these suggestions.