Response to referee comments and suggestions on bg-2018-521 by N. Löbs et al.: "Microclimatic and ecophysiological conditions experienced by epiphytic bryophytes in an Amazonian rain forest"

Manuscript format description:
Black text shows the original referee comment, and blue text shows the response of the authors and the explicit change in the text. The figure and table numbers refer to in the revised manuscript.

Anonymous Referee #3 submitted the comments RC4

Received and published: 25 February 2019

General referee comments:

Dear Editor, dear authors

I have read with interest the manuscript entitled "Microclimatic and ecophysiological conditions experienced by epiphytic bryophytes in an Amazonian rain forest" by Löbs et al. submitted to Biogeosciences. Please find my comments related to it below:

I appreciate a strong point in this manuscript that is to contribute to raise the data availability regarding cryptogamic covers functional performance in tropical regions, and going further, the lack of data available in Central and South America. It seems that almost all the literature regarding this issue has been focused in Polar Regions some years ago and in drylands at the present. I also appreciate the novelty and the effort made to provide microclimatic data sets at those heights at the tree trunks. If we want to understand properly the relevance of these organisms in global cycles and their response under environmental changes a huge and very different biome as the tropics cannot be ignored. I think that authors do a complete revision of the literature available and try to contribute from there with their data. Mosses dominate cryptogamic covers in tropical regions in biodiversity, so the target organisms in the study seems to be quite correct.

General author response:

We would like to thank the reviewer for appreciating our work and for the efforts spent on our manuscript. His/her comments helped us to substantially improve it.

Referee comment 1:

But, at the same time, my opinion is that this lack of data availability in the region is an intrinsic weakness of the manuscript. My point here is that the manuscript is based in a double assumption rather than in strictly measured data sets. The first assumption would be the water content of the bryophytes through conductivity sensors.

I appreciate the effort made by the authors calibrating this methodology in the lab and this experimental testing gives higher credibility to the measurements. But then we see the big second assumption that is to extrapolate data taken from the literature to understand the functional performance of the bryophytes in the altitudinal gradient. I think that it is likely that possible inaccuracies could arise in this sense. Data available in the literature is little, so, it must be difficult to find similar experimental designs that could help providing reliable extrapolations. I am not talking about finding same species with data available in the literature, but it would be interesting, in order to trust the ecophysiological data provided, to have data from a similar habitat following at least the light adaptation patterns of the species included in this work.

As I suppose that these data sets are very difficult to get, but I think that this manuscript is interesting and useful to the scientific community, I would make a proposal to the authors:

What about to include in your manuscript a few gas exchange checkpoints in the lab including relevant species inside the gradient. For example, one representative species in the understory and another one at the closer point of the canopy could serve as cardinal points to calibrate authors' predictions about net photosynthesis availability, time and amount of respiration and possible C losses, light cardinal points, adaptation strategies. This would improve the discussion substantially from my point of view.

I am not asking for a complete gas exchange profile of the species included in the study because I know how time consuming this technique is, just a few replicated checkpoints in the lab to see how close predictions are from reality. If they were far from each other, the real gas exchange parameters measured could work as a more reliable source of predictions than a very likely imprecise literature for the aim targeted. I would welcome further assumptions at this point, but based in some real measured values (I said in the lab because conditions are easier to control, but some field gas exchange data sound good for me also). I think that this could improve the manuscript and put it as a reference text in tropical epiphytic bryophytes functional performance due to the low amount of literature available.

Author comment 1:

Thank you very much for these constructive ideas on CO_2 gas exchange measurements. It indeed would be good to include some measurements conducted by ourselves. However, from past experiences we know that quick gas exchange measurements might deliver truly misleading results. Just as an example, it has been shown by colleagues, that after transport to the lab, tropical organisms showed only a fraction of the physiological activity previously assessed in the field. The samples had strongly suffered from the transport, as they had to be air-dried prior to the transport in order to avoid molding during that time. Thus, we think that CO_2 gas exchange measurements indeed make sense, but that they also need to be conducted with care. This indeed is planned for the future, but would go beyond the scope of the current study. For the present study, we found some very good data on lowland rain forest bryophytes, assessed by a group, which is well-experienced in CO_2 gas exchange measurements. Thus, for the current study we decided to use their results in order to assess potential physiological activity patterns, but we also stress the potential sources of error and inaccuracy of this approach. We hope that we could convince you of the validity of this approach.

During the review process, we conducted a complete revision of the calibration process for the water content sensors resulting in by far smaller inaccuracies.

Some minor points also to comment:

INTRO

Referee comment 2:

Page 3, Ls 20-25: I would focus in bryophytes functional properties rather than in general physiological features of cryptogamic covers because only bryophytes are included in the experimental design.

Author comment 2:

Thank you for this comment. The whole introduction was revised, with the aim to focus more on the epiphytic bryophyte communities.

Author changes in the text 2:

P2 L 24: "Epiphytic cryptogam communities comprise photoautotrophic bryophytes, algae, lichens, and cyanobacteria in varying compositions, growing together with heterotrophic fungi, other bacteria, and archaea. They can colonize plant surfaces in almost all habitats throughout the world (Büdel, 2002; Elbert et al., 2012; Freiberg, 1999). Epiphytic bryophytes in the tropics play a prominent role in environmental nutrient cycling (Coxson et al., 1992; Zotz et al., 1997) and also influence the microclimate within the forest (Porada et al., 2018), thus contributing to the overall fitness of the host plants and the surrounding vegetation (Zartman, 2003). However, they are equally affected by deforestation and an increasing fragmentation (Zartman, 2003; Zotz et al., 1997).

Physiologically, cryptogamic organisms in general and specifically also bryophytes are characterized by their poikilohydric nature, as they do not actively regulate their water status, but passively follow the water conditions of their surrounding environment (Walter and Stadelmann, 1968). In a dry state, many bryophytes can outlast extreme weather conditions, being reactivated by water (Oliver et al., 2005; Proctor, 2000; Proctor et al., 2007; Seel et al., 1992), and for several species also fog and dew can serve as a source of water (Lancaster et al., 1984; Lange et al., 2006; Lange and Kilian, 1985; Reiter et al., 2008). Accordingly, their physiological activity is primarily regulated by the presence of water and only secondarily by light and temperature (Green and Proctor, 2016)."

METHODOLOGY

Referee comment 3:

-Section 2.5. Could you please explain in more detail why some meteorological parameters are measured at 26m and light is measured at 75m?

Author comment 3:

Monitoring of the meteorological parameters is conducted in the course of the overall ATTO long-term measurements (for more details see Andreae et al., 2015). For this, different sensors have been installed at different heights in order to serve the needs. Ambient light is measured at 75 m in order to avoid shading of the canopy and also precipitation and fog need to be measured above the canopy (at 81 and 50 m height, respectively). The different height levels are also explained by the different amounts of space needed by the sensors. We see that as uncritical for these parameters, as ambient light intensity, fog, and precipitation should not vary between 50 and 81 m height. For relative ambient air humidity and ambient temperature we decided to use the data closest to the canopy, i.e. at 26 m height.

In the revised version of the manuscript, we provide the information that the meteorological parameters are assessed in the course of the long-term monitoring at the site and we also provide a scheme illustrating the different sensor locations below, within and above the canopy. We hope this will clarify the sensor setup in some more detail.

Author changes in the text 3:

P8 L14: "The meteorological parameters have been measured within the ATTO project *in the context of longterm monitoring* since 2012.

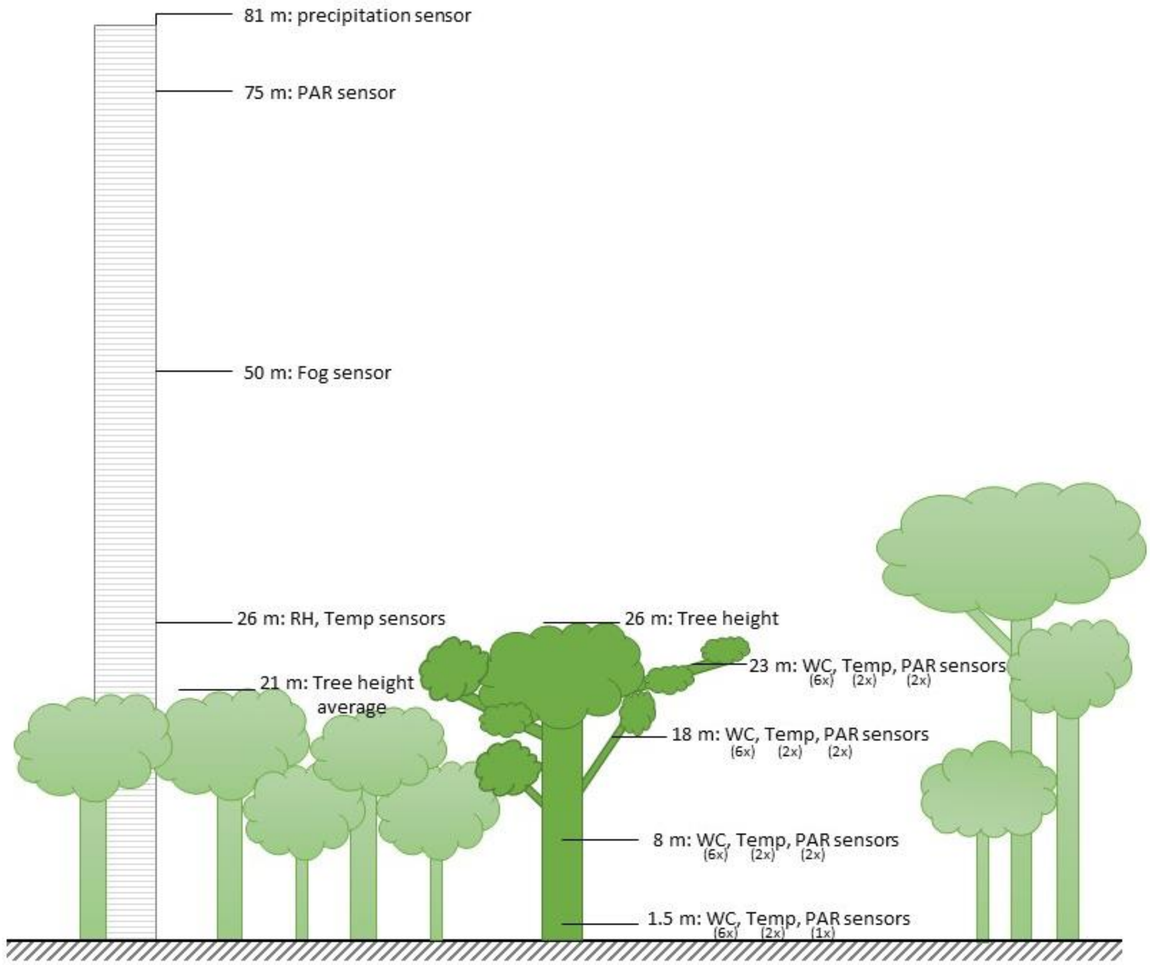

Figure S2: Schematic overview on the sensors installed at different height levels below, within, and above the canopy. The parameters water content (WC) and temperature (Temp) were measured within the bryophyte samples, the light sensors (PAR) were installed directly on top of the thalli. The average tree height of 21 m was determined for the plateau forest in general.

Referee comment 4:

-Section 2.6. I would establish the possible ranges for each ecophysiological parameter analyzed focusing more in tropical epiphytic bryophytes functional performance.

Author comment 4:

Yes, this entire estimation was revised to restrict the considered values to epiphytic bryophytes of tropical lowland forests.

Author change in the text 4:

Changes in Table S3.

Table S3: Parameters determining fractional time of photosynthesis and respiration. The lower water compensation point (WCP_l), the lower light compensation point (LCP_l), the temperature for optimal net photosynthesis (T_{opt} NP), and the upper temperature compensation point (TCP) as relevant parameters have been extracted from published studies conducted at lowland sites of tropical rain forests.

Parameter	Low	High	Unit	Reference	Study site
WCP_l	30	80	% DW	Wagner et al 2013	Panama, lowland rain forest, 0 m
LCP_l	3	12	µmol m^{-2} s^{-1} PPFD	Lösch et al. 1994	Zaire, lowland rain forest, 800 m
T_{opt} NP	24	27	°C	Wagner et al 2013	Panama, lowland rain forest, 0 m
TCP	30	36	°C	Wagner et al 2013	Panama, lowland rain forest, 0 m

RESULTS

Referee comment 5:

-Section 3.1. 2 consecutive years of microclimatic data availability is a good and interesting output provided by authors

Author comment 5:

Yes, this is a long term monitoring project and the database on the water content, temperature, and light conditions of epiphytes is uploaded to the ATTO data portal (www.attoproject.org/).The data thus are maintained, obtain a doi and can be retrieved from that site.

Author comment 6:

Indeed, it was not an easy task to structure the manuscript in a logical way and in the end we decided to use a structure to analyze the data according to different time frames (i.e., comparison of years, seasons, diel cycles, etc.). Thus, indeed, different climatic parameters are sometimes used within one paragraph to illustrate their interdependence. However, we also considered this comment and looked over the structure within the paragraphs again. We now avoid mixing different parameters wherever this is possible.

Author change in the text 6:

Some structural changes will be made throughout the manuscript in order to obtain an overall easier readability.

Referee comment 7:

P 10 L9, I think that authors missed a word after ”35%”, maybe “lower”?

Author comment 7:

Yes, “35 % *lower*”, we added the word.

Author change in the text 7:

P10 L20: "Comparing the two consecutive years, the effect of an El Niño event was clearly detectable, as rainfall amounts were 35 % *lower* (525 mm versus 805 mm) and relative air humidity 11 % lower (81 % versus 92 %) between October 2015 and February 2016 than in the previous year (Fig. 1, Table 1)."

Referee comment 8:

How did authors compare climate statistically between years/seasons? Did you use a monthly basis? Daily basis?

Author comment 8:

The statistical comparison between the years was performed on the basis of 5-minute data points. The statistical tests and the data base being used will be explained in more detail in the Section "2.6 Statistical analysis" and in the header of each table, were results are presented.

Author changes in the text 8:

Table 1: Annual mean values…"Mean values and statistical tests were calculated from 5-minute intervals, except for PAR_{max}, where the daily maximums values were considered."

Table 2: Seasonal mean values…" Mean values for the respective seasons were calculated from 5-minute intervals of the years 2015 and 2016, except for PAR_{max}, where the daily maximum values were considered."

Referee comment 9:

P 10 L 25-26. If I understood ok, the idea is that the microclimatic T value at the moss level was higher than ambient T, and that this is a frequent pattern. What about the shading effect of the tree canopy over microclimatic T?

Author comment 9:

Yes, indeed there is some shading effect of the canopy, which could result in a reduced heating of the bryophytes, also at 23 m height within the canopy. However, also ambient T measurements are always performed in the shade to avoid a short-term impact of direct insulation. Thus, we do not think that there is a large difference in shading. However, we think that wind intensities are reduced within and below the canopy and that the bryophytes have a higher heat storage capacity, which both may cause higher temperatures measured within the bryophytes.

Referee comment 10:

Fig 1, legend. I would say estimated water content of the bryophytes rather than "ecophysiological conditions"

Author comment 10:

The expression "*ecophysiological*" was finally omitted and was changed throughout the text and figures and replaced by "*conditions of bryophytes*".

Author change in the text 10:

Figure 1: "*Water content, temperature, and light condition of bryophytes, and above-canopy meteorological conditions experienced* in the Amazonian rain forest."

DISCUSSION:

Referee comment 11:

P 14 Ls 22-24. I think that these patterns observed reinforces that measuring some gas exchange control points might be useful.

Author comment 11:

We completely agree that additional CO_2 gas exchange measurements would be of interest. Our hesitation to measure just some cardinal points is explained in the first section of this response letter. We also explain there, that, under the current conditions, we prefer to use a well-established study over quick measurements conducted by ourselves. We prefer to conduct an in-depth CO_2 gas exchange study in the near future, which, however, goes beyond the scope of the current manuscript at hand.

Referee comment 12:

P 4 line 13: Remove "The".

Author comment 12:

Yes, the word was removed.

Referee comment 13:

P 17 Ls 19-23. I do not understand this point properly.

Author comment 13:

This paragraph was adapted to clarify the information. The intention was to express that respiration is more sensitive to temperature than photosynthesis.

Author change in the text 13:

P 18 L9: "Temperature regulates the overall velocity of metabolic processes. Whereas it has a strong impact on respiration, the photosynthetic light reactions are by far less sensitive to temperature (Green and Proctor, 2016; Lange et al., 1998). Since net photosynthesis is the sum of simultaneously occurring photosynthesis and respiration processes, positive net photosynthesis rates may still be reached at higher temperatures in the light, as long as the photosynthetic capacity is high enough, whereas during the night, high temperatures could cause a major loss of carbon due to high respiration rates (Lange et al., 2000).

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