

Biogeosciences Discuss., author comment AC1
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Reply on RC1

Maiju Linkosalmi et al.

Author comment on "Tracking vegetation phenology of pristine northern boreal peatlands by combining digital photography with CO₂ flux and remote sensing data" by Maiju Linkosalmi et al., Biogeosciences Discuss., <https://doi.org/10.5194/bg-2022-58-AC1>, 2022

Response to Referee #1

We thank the reviewer for assessing the manuscript carefully and for the constructive and supportive comments. We have addressed all the comments and questions that were raised (in italics), and the responses are listed below:

Linkosalmi et al.'s study looked at vegetation phenology at three different boreal peatland sites across 5 different years, linking imagery taken from digital cameras, satellite imagery and productivity data from eddy covariance flux towers. The authors used the green chromatic coordinate to investigate patterns of greenness, and to evaluate the influence of environmental parameters such as temperature and water table level on GCC and subsequent gross primary productivity measurements. I would like to thank the authors for what is a nicely written paper. Overall, it was clear and concise, presenting the data in a coherent and logical manner. You do state you look at water table, but this was not clear to me in your analyses (in fact, it seems missing from the statistical analyses? I would like the authors to expand on how they related GCC and GPP exactly as I felt this was lacking.

Response: The authors thank the referee for the supportive comments. We also thank the reviewer for the remark concerning the water table level. The changes in water table level are discussed in relation to changes in temperature in Section 3.2., and we added further discussion about the observed drought. We also revised the aims of the study stated in the introduction.

Detailed comments:

-Line 10: When you state leaf area, do you mean the physical leaf size?

Response: The term 'leaf area' was changed to 'plant cover'.

-Line 14: I presume you mean air temperature here?

Response: Yes, this is specified in the revised manuscript.

-Line 29: Same as abstract, do you mean leaf area as in differences in leaf size?

Response: See above.

-Line 39: Vegetation phenology is quite a broad concept (incorporating a variety of things such as flowering, leaf out etc). I would maybe include the phrase green leaf phenology here to acknowledge this paper is looking at simply 'greenness'.

Response: Thank you for the suggestion. We clarified the sentence. Also, we checked the whole manuscript for terminology and revised the text where necessary to indicate whether the text refers to greenness specifically or vegetation phenology in general.

-Lines 59-63: I was a little confused by the wording here. You state there are three peatlands measured across 5 growing seasons. Your first objective is states however that you would use GCC to describe phenology between sites and among different plant communities at one site. I understand that you are looking at species/community differences within a site, but this makes it sound like you only did this at one site.

Response: For clarity, the sentence was corrected from "...within one site..." to "...within each site..."

-Lines 85-101: Did you consider using any other metrics, even other chromatic coordinates such as the Red Chromatic Coordinate?

Response: The GCC has previously proven to be a valid metric for greenness in peatlands (e.g. Peichl et al. 2015, Linkosalmi et al. 2016, Koebsch et al. 2019), so we decided to use it instead of other indices. The RCC would certainly be an interesting metric, too, for peatland vegetation, but here we wanted focus on the greenness and, in order to keep the amount of data within reasonable limits, the RCC was not included in the analysis.

-Lines 195-201: Really nice to show the GCC vales of different species/communities – this is not all that common in the literature, especially for peatlands.

Response: We thank the referee for the supportive comment.

-Lines 240-250: This section was a little hard to follow, and I would encourage the author to re-word. It was detail heavy (which is good) but makes it really quite dense. In line 242, you mention a p value, but no other information from the results of the statistical test. I would like more details here. A p value alone is not sufficient when reporting the outputs of statistical analyses.

Response: We made some editorial changes to improve the clarity of this paragraph. The p-value in question did not actually refer to any specific statistical test and it was removed. In other Sections, the χ^2 values were added to report the results of statistical analysis, in addition to the p-values.

-Figures 7 and 8: Could you maybe incorporate these two figures to show comparison between GCC and GPP more easily? I'd recommend two columns, left hand side GCC, right hand side GPP, with each site in a column (I hope this makes sense). In Figure 8, for Halsiappa, what is the explanation for the yellow shaded area?

Response: We thank the referee for the suggestion, which was implemented. The explanation for the yellow shaded area (wide confidence interval due to a data gap) at Halssiaapa in 2018 was explained in the results (Section 3.3) and discussion.

-Lines 265-268: The wording of the sentence here is quite confusing. So the difference in GCC was significant between Lompolojankka and other two sites in all years, but only significant between Halsiappa and Kaamanen in the last 3 years of study? Think this could be re-worded to be easier to understand.

Response: The sentence was re-worded for clarity.

-Figure 9: Your GCC values for some of the sites are really quite high (much higher than other boreal peatland studies such as Peichl et al. 2015 and Davidson et al. 2021). Why is that? Was Halssiaapa really that much greener at around Day 240

Response: The values in Fig. 9 represent the satellite derived GCCs, which are higher than the camera derived GCCs (Fig. 7). Peichl et al. (2015) and Davidson et al. (2021) used camera derived indices and their result are in accordance with our data. In discussion, we note that the GCC values differ between satellite and camera derived images and discuss the possible reasons for this ("...the different viewing angles and atmospheric effect (the scattering and absorption of radiation due to atmospheric molecules and aerosols) and the consequent atmospheric correction of the satellite data"). Also, the model fit is still passable, although there is statistical scatter in the data and the point at day 240 represents the highest value.

-Line 319: Again, state green leaf phenology here

Response: Corrected

-Line 326: Wording is a little awkward. You state that Lompolojankka is flatter, but the rest of the sentence also makes it sound like there is pronounced microtopography. This should be clearer.

Response: The sentence was edited. The pronounced microtopography refers to the other two sites (Halssiaapa and Kaamanen)

-Line 328: 'This affects THE fen's' – word the is missing

Response: Corrected

-Line 330: I'd expanded this section. What might a fen dominated by sedges be doing over say, a bog? Higher productivity in the short term? But faster turnover? Discussion section overall seems rather superficial in areas such as this and could benefit from being expanded upon.

Response: The discussion was reworded. The authors meant to discuss the special characteristics of this specific fen, Lompolojänkämä, rather than the general differences between fens and bogs.

-Line 333: How small are the shrubs in this area? Shrubs would typically have a higher GCC unless they are really quite small (thinking Betula spp.?)

Response: The dominant plants that defined the ROI selection at the sites are presented in Table 1. 'Shrubs' refer to species (such as *Andromeda polifolia*, *Empetrum nigrum* at Halssiaapa and Kaamanen) smaller than *Betula* spp., which we have separated as its own ROI. The text was edited and clarified, as greater GCC values were found in general for annuals (such as *Menyanthes trifoliata*) and taller woody plants (such as *Salix* spp. and *Betula* spp.) than for smaller shrubs and sedges, but at Kaamanen the shrubs had a higher GCC than the sedges and mosses.

-Line 336: I wouldn't use the phrase plant growth here, that indicates to me the physical size of the plant, I'd say strictly green leaf phenology.

Response: Corrected

-Lines 340-343: Really cool that you are able to investigate the GCC dynamics of individual plant communities. I would like to highlight another recent paper, investigating GCC dynamics in boreal peatlands, that also looked at community level (finer spatial resolution of 60 x 60 cm) by Davidson et al. 2021: Davidson, S.J., Goud, E.M., Malhotra, A., Estey, C.O., Korsah, P. and Strack, M. (2021) Linear disturbances shift boreal peatland plant communities toward earlier peak greenness, Journal of Geophysical Research: Biogeosciences <https://doi.org/10.1029/2021JG006403>

Response: We thank for the supportive comment and for the reference, which was added to discussion.

-Line 344: This paragraph seemingly comes out of nowhere, and I think it would benefit from having a linking sentence between the previous paragraphs.

Response: The previous paragraph was edited to provide a conceptual link.

-Lines 371-372: This sentence is awkwardly worded and I'm not sure I get the meaning. What does phenological courses mean?

Response: The sentence was edited and "phenological courses" was changed to "phenological development".

-Lines 378-380: I may have missed it, but this key information here about the drought in 2018 – could that be included in the study site? I think some more meteorological data would be a really nice inclusion? Show air temperature and precipitation patterns across the 5 year period (and compared to the climate normal)

Response: We thank for the suggestion. We included a table to show monthly air temperatures and precipitation sums. It was referred to in the description of the study sites as well as in Results and Discussion.

Conclusion: Unfortunately, I feel like the conclusion lets down what is otherwise a nice paper. I would encourage the others, rather than just summarise the paper here, really place their results within the bigger picture. What can this data help with in the future? There is very little discussion about the usefulness of this type of data beyond explaining productivity patterns at these specific sites. Could this data be used to parameterize models? I don't think you need to go crazy here and go beyond the scope of the paper, but I do think summarising just the paper here weakens the conclusion.

Response: We thank the reviewer for the comment. We elaborated the conclusions and added discussion about the use of the data for monitoring and modelling of ecosystems.