

Biogeosciences Discuss., author comment AC3
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Reply on RC3

Romina Llanos et al.

Author comment on "Recent significant decline of strong carbon peat accumulation rates in tropical Andes related to climate change and glacier retreat" by Romina Llanos et al., Biogeosciences Discuss., <https://doi.org/10.5194/bg-2022-47-AC3>, 2022

In order to be able to respond to each of the referee's observations and comments, I will put all of them in "normal" font, and our responses to them in bold italics, to make sure we respond to everything.

The authors present an interesting study on the impact of climate change on Andean peatlands carbon storage. Given the importance of peatlands for the global carbon cycle and climate, I believe this paper is of interest to the readership of this journal. Although the methodology is not particularly novel, the Andean peatlands appear poorly studied (after a quick search on web of science) and any good evidence of climate change impact on this ecosystem would be worth being published.

We really appreciate your comments and positive suggestions that will improve our manuscript.

I have some major comments on the methodology and interpretation of the data that led to certain conclusions and some minor comments to help improve the manuscript overall.

1. I have some concerns about the derivation of accumulation rates and carbon accumulation rates and the logic behind these estimations. First, how is the accumulation rate obtained? This is not presented. Second, why is the CAR computed directly from the accumulation rate? Is the assumption behind this step that carbon moves only top to bottom? I am not able to determine because this methodology is only briefly mentioned here. But if this is the case, what about carbon released from the roots? Could not plant release carbon directly at depth as root exudates? We just need more details and discussion of the assumptions to better evaluate conclusions originating from this approach.

We have changed the term accumulation rate to growth rate, which is more appropriate since all of the material is peat.

Thank you for your observation, there is a little mistake in the formula: CAR was obtained multiplying the growth rate (cm yr^{-1}) by the bulk density ($\text{g cm}^{-3} \text{yr}^{-1}$) and the TOC (%).

The carbon is not supplied from top to bottom. The peat is a mixed system where the plants of the peatlands grow vertically leaving behind the dead and

decomposed organic matter. To this system is added a sedimentary system, not very important quantitatively in our case, whose sediments will be deposited on the surface of the peat. This type of system produces extremely coherent ¹⁴C ages over periods of time ranging from ten to thousands of years, showing the progressive net accumulation of organic matter by these systems.

2. The authors somewhat try to infer the evolution of soil carbon over time as a result of the balance between inputs (from plants) and outputs (decomposition). Is there any estimate of how plant productivity changed over time? Although only from year 2000, MODIS from NASA could help.

We thank you for this suggestion.

We have estimated the primary production from MODIS satellite data (2000-2021) and can observe the variations between the two sites (please see Figure RC3.1: Primary production from MODIS satellite data (2000-2021) for the study area, in SUPPLEMENT). APA1 has an average net primary production (NPP) for the period of 0.37 kg C m⁻² and APA2 of 0.27 kg C m⁻².

The two peatlands have similar vegetation, APA2 is located at 4420m on a gentle slope of the valley, and APA1 is at 4200m and is located on a glacial terrace now incised by the Rio Apacheta which is a few meters lower. So the river does not supply water to APA2 and it turns out that the drainage areas of the two peatlands are not as different as we thought and that the ratio of drainage area to peatland area explains well the difference in accumulation rate between the peatlands. Please see Table RC3.1: Data comparison between both peatlands (APA1 and APA2) in SUPPLEMENT.

3. Most importantly, I believe the authors should considerably improve their discussion of the methodology, give more context about these peatlands, and elaborate more on their research question.

We agree with the referee and will change the text according to this remark.

MINOR COMMENTS

1. There are some issues with the abstract. First, in line 16 the authors introduce carbon accumulation rates (CAR), but then the following line they quantify accumulation rates. From reading the rest of the paper these two quantities are different and have different units. From the abstract it seems they are the same quantity, and it is measured in cm per year. Second, there is no reason to mention APA1 and APA2 here, because a reader does not know what they are at this point. Third, the sentence in lines 20-23 on *Distichia muscoides* does not seem to fit here. This seems a preliminary information that could be mentioned earlier, if necessary. In summary, I would simplify the abstract and keep only information and conclusions that are needed to invite a reader to look at the entire paper.

We took this into account to improve the manuscript.

2. Give at least a brief description of the age-depth model.

We will add this information.

3. Rather than just a simple map, Figure 1 could be used to introduce also trends in temperature and other relevant preliminary information about the sites (e.g., what is presented in fig. 7).

We agree with the suggestion. We will make a new figure 1.

4. Line 174. replace "that" with "than".

We agree.

5. Line 242. Maybe topographic "location" is better than "conditions".

We agree.

6. Lines 276-285. Could you rephrase this whole paragraph?

We will change the text according to this remark and those from other referees.

Please also note the supplement to this comment:

<https://bg.copernicus.org/preprints/bg-2022-47/bg-2022-47-AC3-supplement.pdf>