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# Comment on bg-2022-47

Anonymous Referee #1

Referee 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-RC1, 2022

General comments

Llanos et al. present a record from a sedimentary core from the Apacheta region in the central Peruvian Andes. Four peat cores from high-Andean *Distichia* cushion-plant peatlands were radiocarbon-dated and C accumulation rates, TOC and C stable isotope composition are presented for the four 29-35 cm long peat cores. Based on the presumption by Skrzypek et al. (2011), who interpreted growing season temperature as a determining factor for δ13C in a high-Andean *Distichia* peatland in Peru, the authors reconstruct temperature from both studied peatlands for the period 1970-2015 CE.

The presented research would potentially represent an important contribution of paleodata in a region, where paleoenvironmental data is still very scarce. However, the presentation and interpretation of the data need significant improvement, and currently, the presented research does not represent a sound and elaborate work. Overall presentation, methodological concept, and data interpretation are not ready yet for publication. As the presented research work needs significant improvement on several topics, I do not recommend it for publication in Biogeosciences.

Specific comments

1. The exact coordinates of the investigated sites are missing. However, the sites can somewhat be located with help of Figure 1. By checking the "sub-catchments", I absolutely do not agree with the presented "sub-catchment" area of 130 km² for APA 1, which is situated in a kar valley of Nevado Portuguesa (aka Chicllarazo or Apacheta) and has no connection to the yellow-shaded area. However, without exact coordinates, this remains unclear.

2. The "study area" chapter lacks important information. *Distichia muscoides* is the only plant species mentioned. In the central Peruvian Andes, cushion-plant peatlands are often dominated by *Distichia,* but accompanied by other species, which - depending on site factors - might dominate specific areas of the peatlands (other cushion-formers like *Plantago rigida, Zameioscirpus muticus, Phylloscirpus deserticola* or reed grasses like *Deyeuxia/Calamagrostis*) or grow into the *Distichia* cushions. Further, these peatlands are usually characterized by shallow pools, which form between the cushions (Coronel et al. 2004). No information is given on that, nor on the topography of the peatland, nor on the influence of grazing or other impact by the local population. Further, no information is provided on the possible influence of geothermal springs, which might contribute to the springwater. The presented study did not conduct analysis of the peatlands` spring and surface water (at least pH and conductivity), which is a prerequisite for any peatland study. Noble & McKee (1982) mention geothermal springs for the Nevado Portuguesa area. Can the influence of geothermal water be excluded?

3. The authors point out the relation of carbon peat accumulation rates and glacier retreat, since glaciers have been recognized as "the main water source" for high-Andean peatlands. Line 266 says: "The subsequent reduction in peat growth rates could have been due in part to the decrease in the rate of water inflow from nearby glaciers to peatlands after their complete disappearance." In point of fact, I cannot detect glaciers within the upper catchments of both investigated peatland sites. Many peatlands in the tropical Andes are fed by glacial meltwater. However, the majority of high-Andean peatlands is fed by permafrost (Ruthsatz et al. 2020), and water originates from high-elevation cryogenic soils and glaciolithic deposits (Trombotto 2000). This is the case for the two investigated peatlands (as far as I presume from Figure 1 and Google Earth). Therefore, the whole climate change-related argumentation should not solely focus on glaciers, but also on the very important role of permafrost.

4. For radiocarbon dates, the authors use the SH calibration dataset. Due to a significant influx of Northern Hemisphere air masses and moisture over a substantial part of the continent, especially the tropical central Andes, during the South American Summer Monsoon (SASM), Marsh et al. (2018) recommend using a mixed calibration curve. During the austral spring and summer seasons, the south shift in the ITCZ brings atmospheric $CO_2$ from the Northern Hemisphere to the Andes, which is taken up by the vegetation during the growing season (Schittek et al. 2016). How do the authors explain the use of the SH calibration set?

5. The authors do not pay attention to the effect that bulk peat stable carbon isotopes may reflect the dilution of atmospheric $\delta^{13}CO_2$ and the effects of early stage kinetic fractionation during diagenesis (Esmeijer-Liu et al. 2012) or other factors like dust influx or vegetational changes. For a scientifically sound reconstruction of paleotemperatures, this has to be taken into account.

6. A scientifically sound "high-resolution" record concerning the past 50 years would require age control by applying the Pb/Cs dating method rather than applying CaliBomb upon radiocarbon dating for only 3 samples per core.

7. The stable isotope measurement method is described in only one sentence. How about the use of calibrated laboratory standards and what is the analytical uncertainty?

line 43: change "High-altitude" into "High-elevation"

line 46: "Their most important ecological role..." This sentence should be reworked. First, it should not be evaluated what is the most important ecological role of peatlands. Second, tropical peatlands do not control decomposition processes in the soil!!!

lines 52-75: The focus should be rather on permafrost than on glaciers as the investigated peatlands seemingly are not fed by glacial meltwater.

line 81: Vegetation is not dominated by *Distichia muscoides*! (What is meant by "vegetation"??? Peatland? Steppe?). This is only the case for peatland areas with permanent saturation. The cited literature in this paragraph has no relation to the Apacheta region.

line 90: "The climate of the Apacheta peatlands..." I do not agree with this statement. First, it should be "Apacheta region", second, there definitely is a rainy and a dry season, as this area is affected by the South American summer monsoon.

line 199: Chimner

line 200: *Oxychloe*

line 200: *Azorella* is typical for high-Andean steppe vegetation and never grows inside a peatland.

line 250: "...which are typically associated with glacial dynamics..." I do not agree. *Distichia muscoides* is associated to permanent saturation above 4000 m asl. Its distribution is not restricted to the presence of glaciers.

line 292: "good relationship" What does that mean? Did you conduct any correlation analysis?

Figure 8: The reconstructed air temperatures of the two presented cores, in some parts, differ significantly, although the two coring sites are very close to each other. How do the authors explain this? How about the other two retrieved cores? Is there any results for them?

The following publications are mentioned in the manuscript, but not listed in the references:
Salvador et al. 2014, Huaman et al. 2020, Thompson et al. 2006, Kalnay et al. 1996, Hribljan et al. 2015, Hribljan et al. 2016, Drexler et al. 2015, Cooper et al. 2010, Lourencato et al. 2017, Roa-Garcia et al. 2016, Lähteenoja et al. 2013, Hapsari et al. 2017, Craft & Richardson 1993, Tolonen & Turunen 1996, Turunen et al. 2001, Chimner & Cooper 2003, Turunen et al. 2004, Beilman et al. 2009, Van Bellen et al. 2011, Nakatsubo et al. 2014, Chimner et al. 2016, Bao et al. 2010, Mitsch & Gosselink 2007

References:
Coronel J.S., Declerck S., Maldonado M., Ollevier, F. & Brendonck L. (2004): Temporary shallow poolsin high-Andes bofedal peatlands: a limnological characterization at different spatial scales. Archives des Sciences 57: 85-96.

Noble D.C. & McKee E.H. (1982): Nevado Portugueza volcanic center, central Peru; a Pliocene central volcano-collapse caldera complex with associated silver mineralization. Economic Geology 77(8): 1893-1900.

Ruthsatz B., Schittek K. & Backes B. (2020): The vegetation of cushion peatlands in the Argentine Andes and changes in their floristic composition across a latitudinal gradient from 39°S to 22°S. Phytocoenologia 50(3): 249-278.

Trombotto, D. (2000): Survey of cryogenic processes, periglacial forms and permafrost conditions in South America. Revista do Instituto Geológico 21: 33–55.

Marsh E.J., Bruno M.C., Fritz S.C., Baker P, Capriles J.M. & Hastorf C.A. (2018): IntCal, SHCal, or a Mixed Curve? Choosing a 14C Calibration Curve for Archaeological and Paleoenvironmental Records from Tropical South America. Radiocarbon 60(3): 925-940.

Schittek, K., Kock, S.T., Lücke, A., Hense, J., Ohlendorf, C., Kulemeyer, J.J., Lupo, L.C. & Schäbitz, F. 2016. A high-altitude peatland record of environmental changes in the NW Argentine Andes (24°S) over the last 2100 years. Climate of the Past 12: 1165–1180.

Esmeijer-Liu A.J., Kürschner W.M., Lotter A.F., Verhoeven J.T.A. & Goslar T. (2012): Stable carbon and nitrogen isotopes in a peat profile are influenced by early stage diagenesis and changes in atmospheric CO2 and N deposition. Water Air Soil Pollut 223: 2007-2022.