



EGUsphere, referee comment RC1  
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## Comment on egusphere-2022-537

Anonymous Referee #1

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Referee comment on "Hydroclimate reconstruction during the last 1000 years inferred by mineralogical and geochemical composition of a sediment core from Lake-Azuei (Haiti)" by David Noncent et al., EGU sphere, <https://doi.org/10.5194/egusphere-2022-537-RC1>, 2022

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The primary requirement for a paleoenvironmental reconstruction to be fit for publication in *Climate of the Past* is that the data are sufficiently robust to stand on their own as a time series of past climate variability at the study site. Unfortunately this is not the case here: most interpretations of the sediment-based proxies are either ambiguous, or reflect sedimentological changes with at best indirect relationship to climate, or both. Moreover the radiometric chronology (based on  $^{210}\text{Pb}$  and  $^{14}\text{C}$  dating) is strongly influenced by depositional instability at the coring site and old-carbon age offsets, compromising age assignment of proxy signatures at the time scale required for meaningful reconstruction of climate variability within the last millennium. As a result, the best the authors can achieve is to conclude that this lake-based climate-proxy record from Haiti is consistent (or at least, not conflicting) with other climate-proxy records from the Caribbean region published already. Consequently this new record could not carry much weight in a regional synthesis of past climate change without some amount of circular reasoning, and thus impede rather than promote understanding of what really happened.

Moreover the claimed results of this study are compromised by a number of methodological defects:

- 1) Although no scale is provided on the map of Fig.1a, it appears that the coring site is located a few hundred meter offshore and close to the principal river inflow area, where subsurface currents may have affected continuity of sediment deposition (cf. below). In addition, considering the demonstrated hydrological sensitivity of Lake Azuei (4m lake-level fluctuation between 1985 and 2014), it is very likely that in the course of the past millennium this endorheic lake has experienced dry episodes when lake depth was reduced by 10m or more, and stable sediment accumulation was restricted to a much smaller area of lake bottom than is the case today. In such a system, the only sensible location from which to recover a sediment sequence aimed at reconstructing past climate-driven hydrological variability is in the central lake floor area around the current maximum depth of 30m. Only there can the depositional environment be assumed to have been sufficiently stable throughout the period of interest to ensure continuous registration of climate-driven water-balance changes as variation in sedimentary climate proxies. The

'Bolivia' corer used here is a push-rod operated single-drive piston corer, which (without casing) limits sediment coring to water depths less than 20m; however even with that logistical limitation it would have been more sensible to select a coring location in the wide north-western part of the lake where large areas of more gently sloping lake bottom occur than in its steep-sided southeastern corner.

In this context, absence of coarse sand layers in the recovered core sequence is by no means a guarantee of continuous lacustrine sedimentation; see Dearing (1999) *J. Paleolimnol.* and Verschuren (1999) *Quat. Sci. Rev.* In fact the high concentration of gastropods around 40cm depth is a classic example of a shell lag deposit, meaning that during an extended period bottom currents winnowed away all fine-grained sediment components (i.e., the clays and silts containing the climate proxies) and deposited them in quieter deeper waters farther offshore; leaving the relatively heavy shells behind. Not coincidentally this interval in the core coincides with a major shift in sedimentation rate. In short, "microscopic observation of fine grains of authigenic limestone in some samples" (lines 213-214) does not suffice to suggest that "the coring site is well protected" and "sediment deposition occurred in a low-energy environment" (lines 214-216) throughout the ~1000 years covered by this sequence. It may be the case at the present-day high lake level, but certainly has not been the case throughout the period of this reconstruction.

2) The 'reservoir-corrected'  $^{14}\text{C}$  age of 48 +/- 25 BP at 7cm core depth is stated to correspond to a calibrated age of 1970 CE (i.e., 48 years before the year of core collection), while 'BP' is formally expressed relative to 1950 CE and thus '48 BP' actually corresponds to 1902 CE. Therefore the reported sediment ages may be on the order of 70 years too young. Also it is far from clear how a sediment age of 48 years at 7cm depth is derived from the  $^{210}\text{Pb}$ -activity values provided in Table 2; and further the text refers to results of  $^{137}\text{Cs}$  dating (line 183) but these are not shown.

3) Except for grey level no proxy data are available from the uppermost 7cm of the core, presumably because these uppermost 1-cm sediment slices were entirely allocated to  $^{210}\text{Pb}$  (and  $^{137}\text{Cs}$ ?) dating. Leaving open the question whether this dating effort really required to sacrifice that much mud, if radio-isotope activity was measured via gamma radiation then the dated sediment samples have remained intact and therefore could still have been subjected to the proxy analyses performed on the rest of the core. Now this study lacks proxy data from the last five decades, while such data are all-important for assessing the magnitude of proxy variability from within the period with independent historical data on the lake's hydrological sensitivity.

4) As a general rule, plots of variation in sedimentation rate cannot be more resolved than the number of absolute age markers constraining the age model. Most of the 34 black circles shown in Fig.2b are thus not real data points but interpolated values; this is evidently misleading. Moreover the slight 'upswing' of the age-depth curve below the lowermost age marker is an unconstrained and correctable artefact of rBacon software, and thus the apparent near-doubling of sedimentation rate between ~1000 CE and ~1050 CE is not real.

5) Wavelet analysis of proxy data only makes sense when temporal resolution is constant throughout the record. In (non-varved) lake-sediment records it is often problematic because radiometric dating typically cannot constrain the time axis to the level required to validate this assumption of constancy. Wavelet analysis is particularly ill-fated in this record, where sedimentation rate (to the extent that it has been constrained) varies by a factor of five. Although the text makes no mention of the linear resolution of the grey-level data series (it seems to be around 2mm?), it is quite clear that the apparent lack of inter-annual and decade-scale hydrological variation during the broader Little Ice Age period (Fig. 7j: ~1400-1900 CE) corresponds with the core section with low sedimentation rate (Fig. 2b: ~0.5mm/year). Thus the apparent absence of 'ENSO', 'PDO' and 'AMO' climate forcing during this period is most likely an artefact of insufficient proxy resolution. To make the results of this exercise credible, the grey-level time series must have a temporal resolution of at least one observation per year, i.e. a linear resolution of at least 0.5mm.

Below a non-exhaustive list of instances illustrating ambiguity in proxy interpretation:

Lines 272-273, "regional-scale processes affect the input of these elements into the lake": this refers to variation of moisture-balance components (overland flow, river input) across the catchment of Lake Azuei, not climate dynamics at the scale of the (northern) Caribbean region.

Lines 298-302, "The negative anomalies of Ca may be the result of increased dilution by terrigenous particles derived from erosion (Baumann et al., 1993). On the other hand, the positive anomalies of Ca are linked to precipitations of calcium carbonates when there is a decrease in terrigenous elements (negative anomalies of sum Al, Fe, and Ti)": Here Ca-calcite is interpreted to reflect authigenous precipitation from the water column, whereas previously (e.g., 231-234) it was interpreted to represent detrital carbonate eroded from catchment rocks.

Lines 323-325, "The opposite variations of Ca-calcite and Mg-calcite in the Lake Azuei sediments (Fig. 5) can be used to interpret changes in water temperature, and thus used as a proxy of water lake evaporation": here both carbonate phases are interpreted to result from authigenous precipitation; and their relative abundance to be a proxy for past temperature change. This inevitably leads to the authors to conclude that "during the LIA period (1400-1800 CE), we observed positive anomalies for the Mg-calcite and negative anomalies for the Ca-calcite, indicating that the lake water was warmer [during the LIA] than during the MCA period (1000-1100 CE), which is characterized by negative and positive anomalies for Mg-calcite and Ca-calcite, respectively" (lines 325-329). Yet the data of Black et al. (2004) "suggests that the Caribbean and tropical North Atlantic were warmer during the MCA" (lines 401-404).

In truth, temperature-controlled evaporation is a dominant influence on the speciation of carbonate minerals only in hydrologically open lakes (as are the study sites referred to in several of the cited publications). In hydrologically-closed lakes such as Azuei the temperature effect is overwhelmed by changes in lake volume and residence time due to

hydroclimatic (i.e., moisture-balance) variation. Apparent undecidedness on the part of the authors about what their sedimentary proxies actually represent reveals incomplete understanding of the aspects of lake functioning and aquatic geochemistry that have produced this climate-proxy archive. It also highlights the difficulty to distinguish between past variations in temperature and rainfall over the study region from lake-sediment proxies.

Lines 339-341: "calcite neoformation" seems to refer here to in-lake Mg-calcite precipitation, whereas "Ca-calcite precipitation" refers to deposition of detrital carbonate eroded from the catchment. But then where does the "neoformation of Ca-calcite" come from?

Lines 354-356, "Indeed, from 1700 CE we observe an increase in Corg content and the grey level shows darker colors. This input of Corg into the lake could be due to deforestation resulting from the establishment of sugar cane plantations": given that the organic content of (oxidized) terrestrial soils is typically much lower than that of most lake sediments, increased sedimentation due to erosion of catchment soils (here x8, based on Fig.2b!) typically leads to lower, not higher sedimentary Corg content, unless this soil influx provides essential nutrients for greatly enhanced productivity of lake phytoplankton, in which case the sedimentary Corg is mostly of aquatic, not terrestrial origin.