

Interactive comment on “Late Pleistocene to Holocene climate and limnological changes at Lake Karakul (Pamir Mountains, Tajikistan)” by Liv Heinecke et al.

BW Wuennemann (Referee)

wuenne@zedat.fu-berlin.de

Received and published: 4 May 2016

General statements

The authors Heinecke et al. used a variety of different proxy records from the eastern basin of Lake Karakul and reconstructed climate-driven sedimentary processes throughout the last 28 kyr BP. They combined endmember modelling approaches on grain size data with geochemical parameters (TOC, TIC, TN/CN, TiO₂), stable ¹³C and ¹⁸O isotopes from authigenic carbonate and selected xrf-derived ratios of Sr/Rb, Zr/Rb and Fe/Mn to infer variations in depositional conditions in the lake, governed by the Westerlies and the Summer Monsoon system. According to their grain size results the authors assign all grain size parameters primarily to eolian and fluvial input,

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of which the endmembers EM1,2 and 4 are characteristic of westerly-derived sources whereas the fluvial sediments(EM3) are interpreted as indicators for monsoon precipitation in that region. In general the manuscript is well organized and partly well written. Meanwhile, the figures need substantial improvement for better visualization and clarity. The interpretation of the processes related to climate control remains a matter of debate. The manuscript needs substantial improvement before acceptance can be recommended.

Detailed scientific comments are below

Study site: The description of the study site remains more general. Information about the relationship between the eastern part of the lake and related catchment conditions (glacier contact, inflow regions, former shorelines, potential terraces, and other morphological features such as dunes etc.) close to the drill site are not considered well enough. It should be noted that a larger drainage system enters the lake in close vicinity to the drill site, which could influence the lake record to a certain extent.

Materials and methods. It is a pity that overlapping drilling could not take place which is meanwhile a common practice in drilling activities. The expected “small gaps” between the core sequences are hard to calculate. Even doubling of sediment retrieval could be possible. It would be interesting to know whether a UWITEC ground plate was used to fix the exact opening of the piston within the same hole or whether this was done by more or less free calculation from the rope length. Both, gaps or doubling, can influence the exact stratigraphy and thus also the chronology.

Laboratory analyses: The sentence (lines 23-25) is incomplete. Re-phase. Calculating a mean reservoir error from two modern plants seems reasonable, although there are plenty of examples that the reservoir error at a certain site of the lake can vary considerably. The assumption of unchanged reservoir errors through time is unlikely and limits the validity of the chronology. This should be mentioned. To my knowledge the parameter setting for the Bacon model (mean accumulation rate and memory strength)

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is the default in this model. Hence, it is unclear what has been changed and why it was changed. On the other hand I wonder why the authors did not use $^{210}\text{Pb}/^{137}\text{Cs}$ dating to prove the upper several centimeters of sedimentation and to check the reservoir error of the second dated sample at 0-1 cm depth. Just discarding because of post bomb effects on the age is a somewhat simple explanation. Furthermore, the age of sample no KK12-1 538 shows an unusual low age (2430 \pm 30 14C yr BP). Why does this age correspond to 10313-12057 cal yr BP (Table 1)? Is there a mistake in type writing? If not, this has to be commented.

Results and Discussion: To my understanding, a detailed description of the lithology is missing. A combination with original grain size classes against sediment depth could perhaps show, why the calculated sedimentation rates along the core are so different between 0.15 and 0.84 mm/yr. For example, what is the reason that the upper sediments display much higher rates than the lower parts? Is there a clear change in sediment grain size composition? If not, a clear reason has to be stated. Perhaps the older ages are strongly overestimated.

The explanation with respect to the endmembers seem to be not really consistent. The authors argue that EM 1 is related to very fine far-distance eolian transport, deposited with precipitation events derived from the Westerlies. The same applies to EM2 which is somewhat coarser in grain size. However, the authors mention the potential contribution of these grain size classes also by meltwater from the nearby glaciers. This is a contradicting process which was not thoroughly considered at all. Why is it not possible that meltwater discharge with generally high proportions of clay and silt (glacier milk), producing at least the offshore fine components (EM1 and EM2) at the drill site? If this process would be an important contributor to the overall lacustrine deposition, the inference of westerly-derived remote sources becomes less important. "A dominance of EM2 sediments in the LGM indicates high influx of dust and generally arid and cold conditions" (page 12, lines 6 ff). Why must the climate be arid and cold? There are several papers demonstrating eolian transport also during so-called warm-wet climate

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conditions (e.g. Stauch et al., 2012, QSR, Stauch 2015, ESR). The assignment of fluvial sediments to summer-related runoff (at least from the glaciers as mentioned by the authors because annual precipitation is very low) is reasonable. But why is this water supply related to summer monsoon influence. Where is the real evidence for this? Most of the cited references refer to locations much farther east (Monsoon realm). It is rather doubtful to transfer those results to Lake Karakul region. Furthermore, a recently published paper by Ramisch et al. (2016, SR) shows evidence for the limited northward extension of the summer monsoon during the Lateglacial-Holocene period. Finally, it should be paid more attention on the real catchment-related processes when interpreting grain size data towards almost solely eolian activity in this region, as stated in the abstract and discussion part. The authors argue that changes in redox conditions are due to variations in lake level that induced changes in ventilation (aerobic vs anaerobic conditions). If the core was taken from 12 m water depth, how much deeper water would be necessary to enable anoxic conditions in bottom waters? Furthermore, the data resolution is quite low (10 cm sample distances indicate a resolution of 150-250 years, according to the tentative chronology) which is currently not a step forward in this field of research.

With respect to the figures, some improvements are really necessary: 1. Fig.1 is a copy from Google maps. This is generally ok but it should be mentioned in the figure caption. Also Google maps provide the date of the imagery which might be important to mention. 2. Fig.2 is incomplete. Using Bacon package in R, additional graphs about the data performance, sediment accumulation rate and memory strength should be added. The axis description need to be adjusted (starting with capitals) according to the other figures. Yr cal BP should be replaced by Age (cal yr BP). 3. Fig.3 is the most unpleasant figure because it is too small in size and numbering and provided too thin lines. Lines between the units are not really visible. Each individual graph in both parts should have a numbering too. It is not suitable to refer to fig 3 without mentioning which of the graphs shall be considered. I suggest to split the graphs and show them in horizontal order. You may also decide to present the graphs in color. Furthermore,

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the EM 1-4 should also contain the related process to avoid backward search for the meaning of each EM. The same applies to the PCA axes. You may also think to skip TOCBr from the graphs, as the data are directly comparable with TOC values. This graph may be placed in the supplementary data set. 4. Fig. 4B shows the data from on-shore regions. The figure caption does not fit to the two graphs. It remains unclear what is the meaning of modern pond? Frequency should be replaced by Frequency. 5. Fig 5. Also too thin lines exist, similar to Fig 3 6. Finally, an overall summary figure could be helpful to demonstrate the processes through time and the climatic inferences.

Technical corrections The graphs have to be improved as mentioned above. There are several incomplete sentences which should be corrected during re-writing. English proofread could be helpful too.

Overall rating: Major revision

Interactive comment on Clim. Past Discuss., doi:10.5194/cp-2016-34, 2016.