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

Anonymous Referee #2

Received and published: 6 May 2016

Dear Referee #2,

Thank you for your comments and notes on our manuscript. We will try to incorporate them as much as possible and we are certain, that the quality of the manuscript will benefit from the suggested changes.

The manuscript of Heinecke et al. was prepared and written very well in general. It is expressive that there is a large amount of data produced in this work, and they were applied clearly to support scientific interpretations and to understand climate and hydrological changes in Central Asia. The discussion and conclusions are generally consistent, which are important to understand past climate change in arid central Asia and its connections with the Asian monsoon and the Westerlies. My general recommendation is that this manuscript could be accepted in this journal but after minor revision.

The detailed comments are as followed.

Referee 2 Comment 1

1) It is necessary to improve the quality of Figures and corresponding captions. In particular, for Figure 2 and 3. Apparently, Figure 2 and corresponding section is too simple. Please provide more details in the figure and corresponding descriptions in the section 4.1.

Authors Response 1

Thank you for your comment. We will revise the figure and captions. For Figure 2 we will provide more detail with additional graphs. A more details description of the settings is given in the materials and methods chapter under 3.2.1. However we are happy to add more detail to section 4.1.

Referee 2 Comment 2

For Fig.3, I would suggest to split it into two figures instead of Fig3.A and B then the reader can see more clearly. Please remove the EM.res. scores from Fig.3A for it does not provide any meaningful information.

Authors Response 2

Thank you for this suggestion. We will revise figure 3 and split 3A into two figures to improve readability. We will also remove EMres from the graph.

Referee 2 Comment 2

I strongly suggest to plot paleoenvironmental indicators along geochemical and sedimentary parameters so that the reader will get a straightforward appreciation of the record and the interpretation instead of searching difficultly in the text.

Authors Response 2

Thank you for your comment. We will try and label the graphs, mentioning palaeo-environmental implications to make the figures more self-explanatory.

Referee 2 Comment 3

Please note that there are PCA axis 1 scores and PCA axis 2 scores both in the Fig3.A and B, apparently, they are different but it is confusing and misleading somehow. Please distinct them. Similarly, the zones in two figures are different. I could not follow why they are different and the real question is why there is a mismatch between the so-claimed external and internal processes. The sub-zones should be displayed in the figure, such as Pre-LGM, LGM, late glacial, early and middle Holocene.

Authors Response 3

We will include a more specific name (eg. PCA axis 2 scores *internal*) into the description and figures which will make it more clear. The three zones for the internal and external parameters are based on the CONNIS cluster analysis of the proxies . In the figure of the PCAs (Fig. 5) these three zones are marked by different symbols according to the zones of the internal and external plots and in agreement with figure 3.

Referee 2 Comment 4

For Fig.4 the captions of A and B are obviously reversed.

Author Comment 4

We will revise the captions and adjust them. Thank you.

Referee 2 Comment 5

For Fig.5, the legend should be placed at a better position so that the plots of A and B would have same size.

Authors Response 5

Thank you for this suggestion. The plots are the same size, however by moving the legend above plot B the axis labels/numeration will be matched better. We will adjust the legend and figure accordingly.

Referee 2 Comment 6

2) The PCA internal axis 2 is interpreted to represent lake level change, but why this is not consistent with the main grain-size data. Normally, for the sediments they tend to be finer when lake level become higher and vice versa. In figure 3, particularly in the zone 3, there is a trend of fining of grain size but a decreasing of lake level.

Authors Response 6

During zone three, which spans the last approximately 6.6 cal kyr BP, we assume a change from wetter to drier conditions. This is for example implied in the increase in EM1, which we assume to be a proxy for far distance dust transport by the Westerlies, and the increasing trend in EM2. On the other hand EM3, which we allocate to fluvial runoff, shows a decreasing trend. A descending lake level in a period of reduced moisture input would therefore not be contradicting.

Referee 2 Comment 7

3) What is the difference between the two periods: pre-LGM and after 6.6 ka, if both periods are dominated by the westerlies, why the geochemical and sedimentary parameters are so different. This could lead to the question on the hypothesis that the interplay between westerlies and Asian monsoon. Why the two atmospheric circulations are always competitive but not cooperative?

Authors Response 7

Thank you for this comment. We assume that the Westerlies are the dominant wind circulation in the region, however there seem to have been drier and wetter phases throughout our investigated time span. While TiO₂, which we assume to be a proxy for far distance dust input, for example shows higher values in external zone 3, the values are lower in the last 6.6 cal kyr BP. On the other hand Sr/Rb and Zr/Rb ratios show a more similar picture in zone one and three.

The hypothesis of the interplay between the Westerlies and die Indian Monsoon has been called into question. It is certain that the changes occurred within the last 29 cal kyr BP and that the pre-LGM to LGM phase as well as the last 6.6 cal kyr BP have been trier, while the late glacial to early – mid Holocene have be more moist. This is clearly reflected in our date. However it is difficult to verify a clear monsoonal influence strictly based on our current dataset. We will formulate our assumptions more carefully.

Referee 2 Comment 8

4) As viewed from oxygen and carbon isotopes, there are no significant variations since late glacial to 2 ka. It is hard to tell how the studying area was impacted by the Asian monsoon and to what extent. So the question is which parameter is relatively good indicator of monsoon or the westerlies

Authors Response 8

Thank you for this comment. It is indeed difficult to allocate the signals to the Westerlies or Indien Monsoon. We are alleviating our assumptions concerning a clear differentiation between Westerlies and Indian Monsoon, which we proposed during the first version of this manuscript in Climate of the Past Discussion. A more details study, maybe on the basis of stable isotopes investigating the source area

signal would be able to lead to clearer results on where the moisture related air masses came from and if they are indeed in parts influenced by the Indian Monsoon as we proposed. Our data, however, at this point seems not to be sufficient enough to clearly allocate the increase moisture to a specific circulation system, and we only imply (based on studies in the region) that the influence of the Indian Monsoon might be reflected in it. If we assume the Westerlies to be a mainly dry stream at this very continental study site, it is reasonable to assume that it is reflected in EM1 (as well as EM2 in parts). EM3, which we allocate to fluvial runoff and thus reflects moisture availability, could be in connected to the Indian Monsoon. However, the Pamir Mountains are located in a transition zone, the topography is complex and studies so far avoid to make precise references to the Indian Monsoon and its northern boundaries are not clearly defined for past times.

Referee 2 Comment 9

5) The general trend of Br is increasing but the TOC is decreasing in the zone 3, could they both be treated as the indicator for productivity?

Authors Response 9

Thank you for this comment. We do not fully agree that TOC is decreasing but Br-inferred TOC increasing in zone 3. Both data sets show increasing values starting at the zone base and a minimum between 250-200 cm core depth. Thus, a more complex structure is visible. However, we focus the discussion on the differences between the zones 1, 2 and 3 and do not discuss the TOC data within the zones in detail. Differences between the two data sets are expected due to the very different methodological approaches and the inhomogeneous sediments containing large macrophyte remains. We would hesitate to say that both TOC and the higher resolution Br data can be used to make inferences about the productivity. They are used as proxies for the organic matter content. And what we can see from the core description is a clear increase in macrophyte remains abundance in the upper part of the core, which corresponds well with zone three. A section with a core description will be included in the revised version of the manuscript, where this will become clearer.

Referee 2 Comments 10

6) It is pity that the results of this manuscript have not been compared with other paleoclimate records in the surrounding and those from different climate and geographic backgrounds. It would be helpful in understanding the general picture of past climate change globally and regionally if the record is compared to the records during the same time intervals.

Authors Response 10

Thank you for this suggestion. While revising the manuscript and figures we will look for a suitable way to include a comparison/summary figure.

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