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Climate of the Past Discussions

Interactive comment on "Rapid waxing and waning of Beringian ice sheet reconcile glacial climate records from around North Pacific" *by* Zhongshi Zhang et al.

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Dear Zhongshi Zhang and co-authors,

Originally, we did not want to step into the discussion of your manuscript, since the conclusions drawn are so obviously in conflict with the geological evidence obtained over the past decades from land records that we thought it is not necessary. However, your replies to the two constructive reviews the manuscript has received push us to do so, since they illustrate that you do not understand or do not want to understand and consider major geological findings.

In our comment we would like to stick to the record of Lake El′gygytgyn, which according to your simulations has repeatedly been covered by an ice sheet that reached a thickness of more then 2 km over the lake at least during MIS 4 and MIS 6. During these times, Lake El′gygytgyn received laminated sediments, which contain organic matter and fossils, are not overconsolidated and do not contain glacial debris, and thus are interpreted as lacustrine sediments deposited during glacial times (therefore named ′glacial facies′) in a stratified water body underneath perennial lake ice (Melles et al. 2007, 2012, Wennrich et al. 2016, and various other papers). Let us stress just a few of your statements concerning these intervals.

(1) In the reply to the review of Julie Brigham-Grette you question the age models of cores PG1351 and ICDP 5011-1 from Lake El′gygytgyn, making it "difficult or uncertain to identify gaps within these sediments". Fact is that the age models for these cores are not just "tuned age models", they are also based on luminescence and paleomagnetic dating (e.g., Nowaczyk et al. 2007, 2013, Melles et al. 2012), complemented and confirmed by respective data and 14C ages from additional cores (Lz1024, Lz1029, Lz1039, Lz1041; e.g., Juschus et al. 2007, 2009). From these results it is clear that deposition in the lake continued during glacial stages via well known processes and that the glacial sediments kept preserved.

(2) In the same reply letter you then identify several gaps based on the magnetic susceptibility data of core PG1351 (without explaining this assumption or giving a reference for that) and question: "In a permanent frozen land and lake, what processes causes these gaps and mass movements?". First, neither the land nor the lake were completely frozen (e.g., Melles et al. 2007, Schwamborn et al. 2012 and many many more papers on the subaquatic deposition and permafrost active-layer behavior through time). Even with a perennial ice-cover, sediment influx occurred during the summer season via the formation of moats along the shores (as known, for instance, from the McMurdo Dry Valleys of the Antarctica; Warwick et al. 2008). Second, the minor gaps in the MS record of core PG1351 are due to the deletion of loop sensor

data at the ends of core segments, not to gaps in the sediments, as could be shown by the correlation of PG1351 with parallel core Lz1024 and deep-drilling core ICDP 5011-1, resulting in a 100% recovery of the Quaternary sequence (see Melles et al. 2011, Frank et al. 2013). And third, mass movements indeed occur throughout the record, although mainly during interglacial times, but in the central part of Lake El′gygytgyn they were associated with minor if any erosion, at least in the time frame of the glaciations simulated by you (Juschus et al. 2009, Sauerbrey et al. 2013, Warnke et al. 2020).

(3) In the reply to reviewer 1 you do not argue against continuous sedimentation during the deposition of the ′glacial facies′ in Lake El′gygytgyn. Instead, in this reply you speculate that "Lake El′gygytgyn could be a subglacial lake when there is an ice sheet on it". This is in clear conflict for instance with the concentrations of organic carbon and the sedimentation of pollen during these periods, and in particular with the accumulation of diatoms, which cannot be supplied by the ice sheet, taking their fragility and the lack of exclusively freshwater sediment sources for the ice sheet. A formation under a floating ice sheet also is not possible, taking the lack of light requested by photosynthesis-performing diatoms.

(4) Finally, we wonder why you do not mention with any word (in the manuscript as well as in both replies to the reviews) the climate modeling that was already carried out to obtain a better understanding of the sediment proxies measured on the Lake El′gygytgyn record (e.g., Melles et al. 2012). In this work numerical climate simulations involving changes in orbital configurations, greenhouse gas concentrations, and continental ice coverage were also not always able to match the climate history evidenced by pollen data in Lake El′gygytgyn, probably due to changes in the oceanic circulation that originate in Antarctica. Why are you so confident that the simulations you run really consider all natural processes and feedback mechanisms that may have occurred in the wide time frame you are dealing with?

We hope with these comments we have made clear enough that you are wrong with your statement that "the glacial sedimentological facies in Lake El′gygytgyn (Melles et

al. 2012) ... needs reinterpretation". As things go: Lake El′gygytgyn by chance is located in the centers of the Beringian ice sheets simulated by your group. This is unfortunate for your model results, but pleasant for science and hopefully will convince the community again that glacial ice coverage in that region was much more limited than suggested by you, as mapped by generations of geologists and geomorphologists.

Regards

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