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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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I believe you continue to miss the point. You are proposing to place an ice sheet over places where other styles of sedimentation were taking place throughout glacial/interglacial cycles, and where a large body of other evidence reveals that the region surrounding Lake El'gygytgyn could not have experienced continental glaciation (Melles et al, 2012; Brigham-Grette et al, 2013). Your response seems to prefer criticizing my suggestions instead of replying to the real problem. The real problem is placing an ice sheet over areas known to be ice free without continental scale ice sheets (Bond, 2019 compilation). Your view of modeling an ice sheet that agrees with

stalagmite in Nevada does not mean you can simply discard all of the cosmogenic isotope ages, radiocarbon dates, and other geochronology for lacustrine and glacial sequences in Beringia (Goetcheus and Birks, 2001; Hamilton, 2001; Brigham-Grette et al. 2003, for example).

The Lake El'gygytgyn record is a continuous sedimentological sequence recording the last 3.6 million years. The sedimentology does have primary facies that we described (Melles et al 2012; Brigham-Grette et al, 2013; Wei et al, 2014), and our conclusions of past climates and depositional environments inferred from these facies are supported by a suite of other independent proxies including total organic carbon, biogenic silica (productivity), diatom taxonomies, and pollen reflecting both cold and warm intervals. Biomarkers, (esp. branched glycerol dialkyl glycerol tetraethers or brGDGTs) produced in the lake by bacteria, have been analyzed at a resolution of $\sim$2,000 years over the length of the entire 3.58 Ma (Holland et al., 2013; D'Anjou et al. 2013; De Wet et al. 2016, Keisling et al., 2017; Castañeda et al, in prep; Daniels et prep) and the leaf wax deuterium isotope record of precipitation is also continuous at a varying resolution of 1 to 5 ka years through glacial and interglacial periods back to 280ka (Habicht et al., in prep). Furthermore, there is new research emerging that shows Lake El'gygytgyn contains evidence of fire in NE Russia (black carbon, PAHs and levoglucosan). And fire appears to be common during cold dry glacial intervals (McConnell et al, in prep). Fires can't ignite under an ice sheet.

A large body of evidence representing research conducted during the past 20 years has all arrived at the same conclusion; that Lake El'gygytgyn has continuously accumulated sediment, including algal and terrestrial organic constituents, since its formation (See, for example papers in Special issue in Climate of the Past on Lake El'gygytgyn). One ice sheet/climate modeling study should not simply ignore such a large body of physical, chemical and biological evidence simply because it does not agree with the output.

The total of the sedimentology and the other proxies confirm our interpretation that this

record is without gaps, precluding the repeated expansion of a 2 km thick ice sheet over the area. We have several peer-reviewed papers describing how the turbidite events were identified and removed from the composite record (see Warnke et al 2020 and references therein). The lake record is documented by over 70 peer reviewed papers focused on the evidence from the lake sediments alone. The chronology of the initial pilot cores that are continuous to about 250ka were dated by infrared stimulated luminescence and radiocarbon, (Forman et al, 2007; Juschus et al., 2007, 2009). There are 8 volcanic ashes preserved in the lake sequence, with the youngest dated to the late Pleistocene (Juschus et al. 2009; van den Bogaard, et. al. 2014).

Aridity cross Beringia was widespread especially in MIS 2 and there are papers suggesting the presence of richer vegetation in riparian areas within a mosaic of landscapes (see Miller et al, 2010 and references there in). You seem to dismiss the glacial record of well-dated moraines in Chukotka, the Brooks Range and Seward Peninsula where MIS 6 (and sometimes MIS 8 and 10) are typically more extensive than MIS2; see the maps (http://instaar.colorado.edu/QGISL/ak_paleoglacier_atlas/gallery/index.html). As suggested in my first review, I strongly suggest you allow your model to correctly reproduce the MIS 2 ice extent (see earlier review for map of Jeff Bond), and the moraines we can visit for MIS 6, then evaluate what an ice sheet in the East Siberian Sea would look like. I maintain that good science considers all of the evidence. You seem to be letting your model control what evidence makes sense. You should consider adapting a multi-model approach that allows for a more critical view of model-dependent output vs. field evidence (see for example Alder and Hostetler, 2017)

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