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Plio-Pleistocene Arctic climate variability: Organic geochemical temperature reconstructions from Lake El'gygytgyn, Far East Russia

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The regional response of the high Arctic to past climate variability is little known prior to ∼100,000 years ago. In 2009, a 3.6 Ma sediment core was recovered from Lake El'gygytgyn (Russia), the largest and oldest unglaciated Arctic lake basin. These sediments offer a unique opportunity to examine Plio-Pleistocene high-latitude continental climate variability. Determining the magnitude of past Arctic temperature and precipitation variability is especially relevant to understanding the mechanisms and feedbacks contributing to arctic amplification. Here we present results of ongoing organic geochemical analyses of Lake El'gygytgyn sediments focusing on 1) the past 800,000 years, 2) on Pleistocene "superglacial-interglacials", which were exceptionally warm intervals at Lake El'gygytgyn (Melles et al., 2012), 3) on the Plio-Pleistocene transition, and 4) on the interval surrounding Marine Isotope Stage (MIS) M2, when pronounced cooling interrupted mid-Pliocene warmth (Brigham-Grette et al., 2013). We use the methylation and cyclization index of branched tetraethers (MBT/CBT) to reconstruct past temperature (Weijers et al., 2007; De Jonge et al., 2014) and plant leaf wax average chain length (ACL) values to examine vegetation change. We find that trends in reconstructed temperatures are in close agreement with pollen-based temperature estimates throughout the entire core although currently calibration of the MBT/CBT proxy to absolute temperature at Lake El'gygytgyn is not straightforward. Our brGDGT temperature reconstructions reveal a strong response to interglacial-glacial variability as well as to local summer insolation, and indicate that the terrestrial Arctic experienced both warm interglacials and mild glacial periods during the Mid-Pleistocene but transitioned to more extreme temperature fluctuations in the more recent part of the record. Plant leaf wax ACL values suggest that Pleistocene glacials were marked by increased aridity, while interglacial periods were wetter at Lake El'gygytgyn. Time-series analysis of the organic geochemical temperature and vegetation reconstructions records reveal variability at precession and obliquity frequencies, respectively. We also find a signal of the Mid-Brunhes Event (MBT) recorded in numerous bulk and organic geochemical Lake El'gygytgyn proxy records. Pre- and post-MBE differences may be attributed to shifts in atmospheric circulation due to the stratification and warming in the North Pacific associated with changes in AABW production (Melles et al., 2012), thus providing further support for teleconnections between the high northern and southern latitudes. Teleconnections between the high northern and high southern latitudes are also evident during superinterglacials as well as during some cooler intervals, including MIS M2.