Quaternary Science Reviews 147 (2016) 406–421

Contents lists available at ScienceDirect

Quaternary Science Reviews

journal homepage: www.elsevier.com/locate/quascirev

Late Quaternary vegetation and lake system dynamics in north-eastern Siberia: Implications for seasonal climate variability

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ARTICLE INFO

Article history:
Received 17 April 2015
Received in revised form
27 July 2015
Accepted 6 August 2015
Available online 3 September 2015

Keywords:
Diatoms
Pollen
Summer and winter temperature
Holocene Thermal Maximum
Aquatic and terrestrial ecosystems
Lake-ice cover

ABSTRACT

Although the climate development over the Holocene in the Northern Hemisphere is well known, palaeolimnological climate reconstructions reveal spatiotemporal variability in northern Eurasia. Here we present a multi-proxy study from north-eastern Siberia combining sediment geochemistry, and diatom and pollen data from lake-sediment cores covering the last 38,000 cal. years. Our results show major changes in pyrite content and fragilarioid diatom species distributions, indicating prolonged seasonal lake-ice cover between ~13,500 and ~8900 cal. years BP and possibly during the 8200 cal. years BP cold event. A pollen-based climate reconstruction generated a mean July temperature of 17.8 °C during the Holocene Thermal Maximum (HTM) between ~8900 and ~4500 cal. years BP. Naviculoid diatoms appear in the late Holocene indicating a shortening of the seasonal ice cover that continues today. Our results reveal a strong correlation between the applied terrestrial and aquatic indicators and natural seasonal climate dynamics in the Holocene. Planktonic diatoms show a strong response to changes in the lake ecosystem due to recent climate warming in the Anthropocene.

We assess other palaeolimnological studies to infer the spatiotemporal pattern of the HTM and affirm that the timing of its onset, a difference of up to 3000 years from north to south, can be well explained by climatic teleconnections. The westerlies brought cold air to this part of Siberia until the Laurentide ice-sheet vanished 7000 years ago. The apparent delayed ending of the HTM in the central Siberian record can be ascribed to the exceedance of ecological thresholds trailing behind increases in winter temperatures and decreases in contrast in insolation between seasons during the mid to late Holocene as well as lacking differentiation between summer and winter trends in paleolimnological reconstructions.

1. Introduction

The Arctic is experiencing unprecedented warming (PAGES 2k consortium, 2013). During the Anthropocene warming has greatly exceeded the global average temperature increase, due to a mechanism called “Arctic amplification” (IPCC, 2013; Miller et al., 2010a). In northern Asia, the effect of recent climate warming is most intense in eastern Siberia (Jones et al., 1999). There, biosphere responses to climate change include not only shifts in geographical distribution but also extinction of species unable to adapt fast enough to new environmental conditions (MacDonald et al., 2008). Subrecent short-term climate changes are also associated with societal reactions, such as the disappearance of northern or alpine

Supplementary data are available at http://dx.doi.org/10.1594/PANGAEA.848906.

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http://dx.doi.org/10.1016/j.quascirev.2015.08.014
0277-3791/