Permafrost, landscape and ecosystem responses to late Quaternary warm stages in Northeast Siberia

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BACKGROUND
Perennially frozen ground is widely distributed in Arctic lowlands and beyond. Permafrost responds sensitive to changes in climate conditions. Climate-driven dynamics of landscape, sedimentation and ecology in periglacial regions are frequently recorded in permafrost deposits. The study of late Quaternary permafrost can therefore reveal past glacial-interglacial and stadial-interstadial environmental dynamics. One of the most striking processes under warming climate conditions is the extensive thawing of permafrost (thermokarst) and subsequent surface subsidence. Thermokarst basins promote the development of lakes, whose sedimentological and paleontological records give insights into past interglacial and interstadial (warm) periods.

INTENTION
In this poster we present results of qualitative and quantitative reconstructions of climate and environmental conditions for the last Interglacial (ca. 130 to 115 ka ago), the lateglacial Allerød Interstadial (ca. 13 to 11 °C ka BP), and the early Holocene (ca. 10.5 to 8 °C ka BP). The study was performed in course of the IPY project #15 ‘Past Permafrost’ with permafrost deposits exposed at the coasts of the Dmitry Laptev Strait (East Siberian Sea).

METHODS
The reconstruction is based on fossil-rich findings of plants (pollen, macro-remains) and invertebrates (beetles, chironomids, ostracods, gastropods), and completed by cryostratigraphic data. Pollen-based reconstructions of mean temperatures of the warmest month (MTWA, \( T_{\text{max}} \)) refer to the best modern analogue (BMA) method (Andreev et al. 2011). \( T_{\text{max}} \) reconstructions by plant macro-fossils employed the coexistence interval approach for modern species (Kienast et al. 2008, 2011), while a transfer function was used for chironomid-based \( T_{\text{max}} \) (Nazarova et al. 2011). Proxy-based paleoclimatic and paleoenvironmental reconstructions were finally compared with simulations produced by an earth system model (ESM) of intermediate complexity, CLIMBER-2 (Andreev et al. 2011).

RESULTS
The here presented palaeoclimate data focus on \( T_{\text{max}} \) as reconstructed by pollen spectra, and for the Last Interglacial additionally by plant macrofossils and chironomids:

Early Holocene (ca. 10.3 to 8 °C ka BP)
- shrub-tundra
- intense thermokarst
- \( T_{\text{max}} \) up to 4 °C warmer than today

Last Interstadial (ca. 13 to 11 °C ka BP)
- tundra-steppe with few shrubs
- intense thermokarst
- \( T_{\text{max}} \) up to 4 °C warmer than today

Last Interglacial (ca. 130 to 115 ka ago)
- shrub-tundra and open forest-tundra
- intense thermokarst
- \( T_{\text{max}} \) up to 10 °C warmer than today

polpen-based \( T_{\text{max}} \): 11 to 17.6 °C
plant macrofossil-based \( T_{\text{max}} \): 12.7 to 13.6 °C
chironomid-based \( T_{\text{max}} \): 12 to 13.8 °C

CONCLUSIONS
Warmer-than-present stages occurred several times during the late Quaternary. Arctic permafrost lowlands responded with intense thermokarst. Vegetation changed from tundra-steppe to shrub tundra or forest tundra communities as reflected by pollen and plant macrofossils. Independent temperature reconstructions mirror quantitative and qualitative ecosystem response to a warming Arctic, especially for the last Interglacial. Comparisons to climate model results are appropriate to understand dynamics of so far less studied periods.

REFERENCES


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