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Assessment of a modern pollen-climate calibration set for Arctic tundra and northern taiga biomes from Yakutia (eastern Siberia) and its applicability to a Holocene record

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The Arctic is expected to respond stronger and earlier to future global warming than other regions world-wide. This region is of particular importance because, on the one hand, even humble climate oscillations can be amplified through complex terrestrial ecosystem reactions. On the other hand, Arctic changes may feedback globally via atmospheric and oceanic circulations or variation of greenhouse gas concentrations. Past variations need to be documented with high confidence to gain important insights in constraints and magnitude of predicted Arctic changes. Documentation beyond instrumental records uses long-term proxy information obtained by analyses of sedimentary archives such as pollen records of lacustrine sediment cores. Reliable climate reconstruction from the warming-sensitive Arctic region are hitherto lacking because a) modern pollen spectra were rarely collected from sedimentary origin, and b) because the obtained reconstructions were not rigorously evaluated.
This investigation aims to establish, evaluate, and apply a modern pollen-climate data set from the transition zone between arctic tundra and light taiga in Arctic Siberia.
Our study area is located in the Northern Siberian Lowlands of Yakutia. Lacustrine samples (n=96) were collected along four north-to-south transects, which cover the major vegetation types and span a broad temperature and precipitation gradient (TJuly: 7.5–18.8°C; Pann: 114-315mm). Redundancy analyses indicated the relationship between modern pollen signal and their corresponding vegetation types and climate. Performance of transfer functions for TJuly and Pann were validated and tested on spatial-autocorrelation effects. They were applied to the one lake pollen record, which covers the last 12,000 years and was retrieved in the Siberian Arctic.
The validation of the calibration set resulted in root mean square errors of prediction of 1.67°C for TJuly and 40mm for Pann, which equal 14.8% (TJuly) and 19.9% (Pann) of the gradient sampled. The application of the models to fossil pollen spectra yielded cold conditions for the Late Glacial period (1-2°C below present TJuly). Warm and moist conditions were reconstructed for the Early to Mid Holocene (2°C higher TJuly than present). Modern conditions were reconstructed for the last 3,500 years.
In conclusion, our regional modern data set fills the gap of existing calibration sets with regard to under-representation of samples from the modern tundra-taiga transition zone and of lake sedimentary origin. Our Holocene climate reconstruction indicates that the Holocene temperature deviation from modern values was only moderate despite the assumed Arctic sensitivity to present climate change.