Long-term fire regime reconstructions in Eastern Siberia based on low-temperature fire markers and sedimentary charcoal: potential and limitations

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Forest fires are an important factor in the global carbon cycle and high latitude ecosystems. Eastern Siberian tundra, summergreen larch-dominated boreal forest on permafrost and evergreen boreal forest have characteristic fire regimes with varying fire intensities. Yet, it is unknown which role fire plays in long-term climate-vegetation-permafrost feedbacks and how high-latitude fire regimes and ecosystems will change in a warmer world. Here, we investigate fire regime shifts during previous interglacials, prior to human presence. We use charcoal as proxy for high-intensity forest fires and anhydrosugars (AS) as molecular proxies for low-temperature biomass burning, typical for surface fires in modern larch forest. However, AS pathways from source to sink and their stability in sediments are very poorly constrained. Recently, Dietze et al. (2020) found AS in up to 420 kyr old sediment of Lake El'gygytgyn (ICDP Site 5011-1), NE Siberia, suggesting that they are suitable proxies for fires in summergreen boreal forests. Surprisingly, the ratios of the AS isomers were exceptionally low compared to published emission ratios from modern combustions. To understand what AS from Arctic lake sediments tell us, we compare late glacial-to-interglacial records with AS and charcoal composition in modern lake surface sediments of Lake El'gygytgyn and three East Siberian lakes that represent spatial analogues to the El'gygytgyn conditions during MIS 5e and 11c. We discuss first results of the modern sediments in context of recent fire extents from MODIS- and Landsat-based fire products and well-explored lake-catchment configurations from TDX-DEM analysis to assess potential source areas and local transport processes. Thereby, we provide insights into the meaning of sedimentary fire proxies, crucial for a sound reconstruction of long-term fire regime histories.

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