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Seasonal climate profiles of an ice-free Arctic based on intra-ring analyses of $\delta^{18}O$ value in fossil wood

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Arctic sea ice thickness and extent are projected to continue their substantial decline during this century, with an 80% reduction in sea-ice extent by 2050. While there is a clear relationship between mean annual temperature (MAT) and the concentration of atmospheric carbon dioxide (pCO_2) across both glacial and interglacial periods, data on seasonal fluctuations is limited. Here we report seasonal temperature estimates for the Arctic during the ice-free conditions of the late early to middle Eocene based upon exquisitely preserved, mummified wood collected from Banks Island, Northwest Territories, Canada (~74 ^{o}N). Annual growth rings identified in the wood specimens were subdivided by hand at sub-millimeter resolution and cellulose was extracted from each sub-sample for determination of stable oxygen isotope ($\delta^{18}O$) value (n = 81). The data reveal a consistent, cyclic pattern of decreasing and increasing $\delta^{18}O$ value up to ~3‰ across growth rings that was consistent with patterns observed in other modern and fossil wood, including from other high latitude sites. From these data we quantified cold month and warm month seasonal temperatures using a previously published model (Schubert and Jahren, 2015, *QSR*, 125: 1-14). Our calculations revealed low overall seasonality in the Arctic during the Eocene with above-freezing winters and mild summers, consistent with the presence of high biomass temperate rainforests. These results highlight the importance of warm winters in maintaining ice-free conditions in the Arctic and suggest that increased winter temperatures in today's Arctic in response to rising pCO_2 will be of particular importance for Arctic ice-loss.