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Reduced Temperature Seasonality in the Eocene Arctic Compared to Modern Determined Using Stable Isotope Measurements ($\delta^{18}O$ and $\delta^{13}C$) of Fossil Wood

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During the early to middle Eocene (~56-41 Ma), elevated CO_2 levels and extreme global warmth maintained ice-free conditions and high-biomass temperate rainforests that thrived across the present-day Canadian High Arctic. Previous researchers have used the rich floral and vertebrate faunal assemblages on Axel Heiberg and Ellesmere Islands to estimate seasonal climate conditions during this time, but only for a narrow region of Canada's eastern Arctic. Existing paleoclimate estimates for this setting have been determined using modern-day analogs, leaf area index, and stable isotope studies of vertebrate fossil bones and teeth, and span a wide range of values, with cold month mean temperature (CMMT) and warm month mean temperature (WMMT) ranging from -2 to 5.5 ºC and 19 to 25 ºC, respectively. We report new quantitative seasonal temperature estimates for Axel Heiberg and Banks Islands, two sites separated by ~1400 km during the early Eocene. Our estimates are based upon intra-ring stable isotope measurements ($\delta^{18}O$ and $\delta^{13}C$) determined across exceptionally well-preserved, mummified wood. In contrast to published paleotemperature data based on modern analog species and leaf physiognomy, our intra-ring $\delta^{18}O$ proxy results indicate above-freezing CMMT at both Axel Heiberg (0.6 to 6.9 ºC) and Banks (3.7 to 9.7 ºC). Summer temperatures (WMMT) fall within previous estimates at Axel Heiberg (16.5 to 24.2 °C) but include slightly lower temperatures at Banks (13.2 to 21.6 °C). These data indicate that exceptional wintertime warmth and low temperature seasonality persisted across the Arctic throughout the extended ice-free climate of the early and middle Eocene and support evidence for reduced meridional and zonal temperature gradients compared to the region today. This result highlights the importance of winter warming in today's Arctic as the driving mechanism for reduced sea-ice extent in response to rising $CO_{2Â}$, and provides a comparison for model outputs using Eocene conditions as an analog for future warming.