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Warm winters and cool summers in the Arctic during the early Eocene determined from isotopes in cellulose extracted from fossil wood

Jacob P. Warner[1], Brian A. Schubert[1], William E. Lukens[2], and A. Hope Jahren[3]

[1]*School of Geosciences, University of Louisiana at Lafayette, Lafayette, Louisiana 70504, USA*
[2]*Department of Geology and Environmental Science, James Madison University, Harrisonburg, Virginia 22807, USA*
[3]*Centre for Earth Evolution and Dynamics, University of Oslo, Oslo N-0315, Norway*

The sediments of northern Canada preserve the remains of lush temperate forests that thrived above the Arctic Circle for millions of years during the Eocene Epoch (55.8-33.9 Ma). Geochemical and paleobotanical analyses across multiple sites have consistently indicated mean annual temperatures ~25 to 30 ^{o}C warmer than present day, but with highly divergent estimates for seasonal temperature (e.g., cold-month mean temperatures ranging from -7.9 to +11.2 ^{o}C, i.e., equivalent to the temperature difference between Wisconsin and Louisiana, USA). Here we report new estimates of cold-month and warm-month mean temperature in the Arctic during the early Eocene based on 80 high-resolution intra-ring oxygen isotope measurements of cellulose ($\delta^{18}O_{cell}$) extracted from fossil tree-rings from Banks Island, Canada. Using published models that quantitatively relate changes in $\delta^{18}O_{cell}$ to changes in seasonal temperature, we calculated very low temperature seasonality, with warm winters and cool summers across the region. Specifically, we found cold month mean temperature = 1.9 to 11.9 °C and warm month mean temperature = 11.6 to 18.0 °C. Potential mechanisms for this reduced seasonality will be discussed, including the effects of high summer rainfall on regulating summertime temperatures. These results indicate the Arctic experienced a greater increase in winter temperatures than summer temperatures in response to past increases in CO_2 level.