Seasonal temperatures in the Arctic during the late Pleistocene determined using high-resolution oxygen isotope measurements across fossil wood

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Cellulose is resistant to degradation on Geologic timescales and provides a reliable record of the oxygen isotope composition of meteoric water ($\delta^{18}O_{MW}$). A strong empirical relationship between the $\delta^{18}O_{MW}$ value and temperature has been observed in modern settings, allowing researchers to reconstruct mean annual temperature *via* measurements of the $\delta^{18}O$ value of cellulose ($\delta^{18}O_{cell}$). Here we present high-resolution intra-annual $\delta^{18}O_{cell}$ measurements across fossil growth rings in mummified wood collected from late Pleistocene sediments (~50,000 to 42,000 ^{14}C BP) within the Yedoma Silt Ice Complex at Duvanny Yar in far northeastern Siberia. These data are used to quantify year-to-year changes in seasonal temperatures at the site, including warm and cold month mean temperatures (T_{max} and T_{min}, respectively). Our results suggest T_{max} = 6.9 ± 2.9 ^{o}C (average ± 1σ) and T_{min} = -37.7 ± 3.0 ^{o}C during the late Pleistocene, which is ~3-6 ^{o}C colder than today's values (modern: T_{max} = 13.1 ± 2.1 ^{o}C, T_{min} = -34.8 ± 2.6 ^{o}C). Assuming a normal distribution for monthly temperatures similar to modern continental climates, we calculate that above-freezing mean monthly temperatures occurred in ~1.7 fewer months during the late Pleistocene than today. These cold conditions allowed for the Arctic to act as a significant carbon sink during the late Pleistocene despite shorter growing seasons compared to today (Parmentier et al., 2011; Strauss et al., 2012). Extrapolation to current Arctic warming suggests that increased temperatures will allow for longer periods of net carbon release from Arctic soils each summer, despite increased photosynthesis.

Parmentier, F. J. W., M. K. van der Molen, J. van Huissteden, S. A. Karsanaev, A. V. Kononov, D. A. Suzdalov, T. C. Maximov, and A. J. Dolman (2011), Longer growing seasons do not increase net carbon uptake in the northeastern Siberian tundra, *J. Geophys. Res.*, 116, G04013, doi:10.1029/2011JG001653.

Strauss, J., L. Schirrmeister, S. Wetterich, A. Borchers, and S. P. Davydov (2012), Grain-size properties and organic-carbon stock of Yedoma Ice Complex permafrost from the Kolyma lowland, northeastern Siberia, *Global Biogeochem. Cycles*, 26, GB3003, doi:10.1029/2011GB004104.