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High sensitivity of Bering Sea winter sea ice to winter insolation and carbon dioxide over the last 5,500 years

Miriam C. Jones Jones[1], Max Berkelhammer[2], Katherine Keller[3], Kei Yoshimura[4], and Matthew J. Wooller[5]

[1]U.S. Geological Survey
[2]University of Illinois Chicago
[3]Harvard University
[4]University of Tokyo
[5]University of Alaska Fairbanks

Anomalously low winter sea-ice extent and early retreat in CE 2018 and 2019 challenges previous notions of relatively stable winter sea ice in the Bering Sea over the instrumental record, but long-term sea-ice records from sediment proxies remain limited. Here we use a record of peat-cellulose oxygen isotopes from St. Matthew Island, along with isotope-enabled general circulation model (IsoGSM) simulations to generate a 5,500-year record of Bering Sea winter sea-ice extent. Results show that over the instrumental period (CE 1979-2018), oxygen isotope variability is largest over the late winter to spring (February, March, April, May [FMAM]) and highly correlated (-0.77, $p<0.00001$) with maximum winter sea-ice extent, months in which Bering sea ice reaches its winter maximum and then rapidly diminishes. We find that over the last 5,500 years, sea ice in the Bering Sea decreased in response to increasing winter insolation and atmospheric CO_2, and on shorter, centennial timescales, small (<10 ppmv) perturbations in atmospheric CO_2, suggesting that the North Pacific is highly sensitive to small (<3 W m^{-2}) changes in radiative forcing. However, we find that reconstructed sea-ice loss lags CO_2 concentrations by ~120 years, indicating that the extremely anomalous recent conditions are a legacy of the early 20th century and that even with a complete cessation of greenhouse gas emissions today. As a consequence, the Bering Sea could lose all winter sea ice by mid-century, which it may not recover for millennia.

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