The effect of insolation and greenhouse gases on sea ice variations in the Okhotsk Sea during the past 180,000 years

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Sea ice is a critical and sensitive component of the Earth’ s climate system, and has undergone dramatic reductions in extent and thickness for much of the Arctic in the last few decades (Budikova, 2009; Bader et al., 2011). However, studies covering orbital timescales are still lacking, largely due to the lack of a reliable sea ice proxy in the subarctic regions, or marine sedimentary archives with sufficient age control and temporal resolution. Here we reconstruct high-resolution subarctic Pacific sea ice and summer sea surface temperature records for the past 180,000 years using novel organic geochemical proxies in the central Okhotsk Sea. Our sea ice reconstruction shows significant precession (23-kyr) cycles, which are coupled to local autumn insolation during intervals of low-mid atmospheric CO_2 concentrations (<~260 ppm). We also find that the Okhotsk Sea was ice-free during the mid-late Holocene and throughout the penultimate interglacial (Marine Isotope Stage 5e) when CO_2 concentration exceeded this threshold, suggesting that both insolation and atmospheric CO_2 levels are responsible for controlling sea ice variation in the Okhotsk Sea on orbital timescales. A proxy-model comparison reveals general agreement between the two approaches.

Keywords: Sea ice, Seasonality, Orbital pacing, CO2 radiative forcing

