New paleoceanographic insights on the Arctic-Pacific gateway: from early Pliocene to modern interactions

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Arctic-Pacific interactions play a critical role in climatic and oceanic processes in the western Arctic (Pacific sector), including the ongoing accelerated sea-ice retreat and related climatic, ecosystemic, and societal changes. Paleoceanographic records from the western Arctic Ocean are key for reconstructing the history of these interactions. Sediment cores from the Chukchi-Alaskan margin and adjacent borderland and deep-water basins give insights into this history from both long-term (late Cenozoic), stratigraphically compressed records, and higher resolution records representing the last deglaciation and the Holocene.

Ages for the oldest sediments recovered are now constrained by strontium isotope stratigraphy developed on biogenic carbonates (benthic foraminifers) from the Northwind Ridge. Sediments estimated as early Pliocene indicate seasonal only sea ice, strong currents, and high water acidity, similar to expected future Arctic Ocean conditions. A pronounced change at ~5 million years (Ma) is tentatively interpreted as the onset of Pacific-Arctic throughflow via the Bering Strait (BS). Characterization of the middle to late Pliocene environments is precluded by a large hiatus, possibly related to high mid-depth current activity. Early Quaternary deposits atop this unconformity indicate stepwise sea-ice advance and growth of ice sheets on adjacent continental margins, consistent with the overall cooling and ice-sheet expansion in the Northern Hemisphere. This trend culminated in a major climatic shift estimated to have occurred near the end of the Mid-Pleistocene Transition, ~0.8 Ma.

Younger Quaternary sediments show high, fluctuating glacial inputs along with mostly perennial background sea-ice conditions. The cyclicity of this sediument stratigraphy can be compared to global climatic proxy curves and astronomically tuned. The dominant cycles, estimated to have ~100 and 20-ka length, are presumably controlled by glacial and sea-ice/atmospheric periodicities, respectively. The latter may be related to interactions of the Arctic with Pacific and/or Atlantic atmospheric circulations.

Higher frequency variabilities, relevant for addressing modern climate changes, can be evaluated in more recent sedimentary records from the Chukchi-Alaskan margin deposited since the last deglaciation and the BS flooding. A depocenter at the Alaskan margin provides high resolution records for sediment delivery by the Alaskan Coastal Current originating from the Bering Sea and controlled by the Aleutian Low (AL) pressure center. Results from the last several centuries indicate a persistent role of the AL in the BS inflow and a complex interaction of its different branches. More proxy studies are underway to reconstruct the history of this circulation system and its relationship with sea ice extent.