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Bering Sea millennial-scale climate variability during Marine Isotope Stages 22 and 21 (∼900 ka): evidence for an active bipolar seesaw?

Sev Kender (1), Ian R. Hall (2), Julia Becker (3), Ivano W. Aiello (4), Taoufik Radi (5), and Hirofumi Asahi (6)

(1) British Geological Survey, Environmental Sciences Centre, Keyworth, Nottingham NG12 5GG, UK (sev.kender@bgs.ac.uk), (2) School of Earth and Ocean Sciences, Cardiff University, Main Building, Cardiff CF10 3YE, UK, (3) Karlsruhe Institute of Technology (KIT), Institute for Meteorology and Climate Research (IMK), Karlsruhe, Germany, (4) Moss Landing Marine Laboratories, 8272 Moss Landing Road, Moss Landing, CA 95039-9647, USA, (5) GEOTOP, Université du Québec à Montréal, Montréal, Qc, H2X 3Y7, Canada, (6) Marine Research Institute, Pusan National University, Busan 609-735, South Korea

The mid-Pleistocene transition (MPT), characterised by glacial intensification and lengthening, is marked by particularly abrupt ice sheet growth during the first ∼100 ka glacial of Marine Isotope Stage (MIS) 22. Millennial-scale climate variability has been proposed to have become intensified during MPT glacials due to North American ice sheet growth beyond a critical size causing basal instability, but direct evidence for intensified millennial-scale climate variability during MIS 22 is so far lacking. In addition, evidence for an active 'bipolar seesaw' during the MPT has not yet been documented, despite this being a critical assumption in synthetically-produced Greenland ice core records. In this study we investigate MIS 22/21 (∼910–840 ka) using high resolution (∼0.3 ka) benthic foraminiferal oxygen isotopes (δ18O), ice-rafted debris (IRD) counts and lower resolution dinoflagellate cyst transfer functions for sea surface conditions, from Bering Sea Site U1343 (IODP Expedition 323, ∼2 km water depth).

During the transition from glacial MIS 22 to interglacial 21, surface water proxies indicate sea ice duration reduced, and productivity increased slightly, both indicative of warming sea surface temperatures during the deglacial. However, coincident with these shifts is a transient reversal (increase) in benthic δ18O, suggesting deep water briefly cooled. We suggest that the transient deglacial deep water cooling at Site U1343 implies a signal originating in the Southern Hemisphere (Ocean), as deep water in the Bering Sea is predominantly composed of Pacific Deep Water, which is sourced from Antarctic Bottom Water. Comparison with a similar resolution record from the North Atlantic (Site U1313) shows an equally transient increase in North Atlantic Deep Water (NADW) production occurred synchronously with the Bering Sea deep water cooling reversal. The coincident Bering Sea surface warming, Southern Ocean cooling, and NADW production increase is similar to the last deglacial, and likely signifies the earliest evidence for an active oceanic thermal bipolar seesaw during the MPT.

Benthic δ18O spectral analysis shows a strong ∼2.5 ka peak, similar to several records from the last glacial North Atlantic, which exhibits higher amplitude during MIS 22 in contrast to MIS 21. Pronounced millennial-scale IRD variability (possibly sourced from the Cordilleran Ice Sheet: low diversity assemblages containing no chert), and benthic δ18O cyclicity during MIS 22, is consistent with previous suggestions that ice sheets became thicker, more extensive and unstable during the MPT.