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A low-latitude driver for Northern Hemispheric ice-sheet build up during the Mid-Pleistocene Transition

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The Mid-Pleistocene Transition (MPT, 1.2–0.6 Ma), characterized by the still elusive switch from a 41 kyr to 100 kyr glacial-interglacial cyclicity, constitutes one of the most prominent changes of climate modes throughout the Cenozoic. The massive expansion of glacial ice sheets commencing between Marine Isotope Stages (MIS) 24–22 is thought to be instrumental for this switch, as it prolonged the response time of the climate system to orbital forcing. This ice-sheet expansion also coincides with the so-called "900 kyr event", a time when the Atlantic Meridional Overturning Circulation (AMOC) critically weakened resulting in prolonged cold sea-surface temperature (SST) conditions in the North Atlantic. Although these cold background conditions favor the sustainability of large ice sheets, they also decrease the atmospheric moisture saturation level, raising a question about the pathways of moisture that would have fed extensive glacier growth in the Northern Hemisphere during that time. Here, we use Mg/Ca-derived mid-latitude Atlantic deep-thermocline temperatures, covering the MPT, to show that decreased thermocline stratification between 40 °N and 60 °N allowed accumulated subsurface heat to reach the surface of the subpolar North Atlantic, particularly during MIS 22. These relatively warm high-latitude SST would have provided a potent moisture source for glacier growth. Our data further indicate that mid-latitude stratification in the North Atlantic is predominantly driven by low-latitude processes, and might therefore act as a mediator for imposing low-latitude climate pacing onto high-latitude glacial ice-sheet dynamics. The combination of this precession-paced low-latitude mechanism for subsurface heat transport into the North Atlantic with the pre-existing obliquity modulation of ice-sheets may have contributed to the emergence of the 100 kyr beat during the MPT.