Temperature and salinity changes in the abyssal Atlantic and Pacific Oceans over the Middle Pleistocene Transition

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Ocean thermohaline circulation (THC) is driven by temperature and salinity in source areas of deep-water formation. THC underwent a fundamental change ~950 to 860 thousand years ago (ka) during the Middle Pleistocene Transition (Pena and Goldstein, 2014). However, the relative contributions of temperature (‘thermo-’) versus salinity (‘haline’) change to this fundamental THC reorganization remain unclear. Here we compiled North Atlantic and Pacific Ocean stacks of deep-water temperature (estimated using foraminiferal Mg/Ca) and salinity (estimated from $\delta^{18}O_{\text{seawater}}$) for the past 1.5-million-years (Myr). The deep North Atlantic became colder and the deep Pacific saltier during glacial periods younger than ~900 ka. Cooling of northern sourced water likely led to increased salinity of southern sourced water by decreasing the melting of land-based ice around Antarctica (Adkins, 2013) and increasing sea ice formation and associated brine rejection. With increased stratification the abyssal ocean became a more effective carbon trap lowering the concentration of atmospheric $pCO_2$, thereby permitting ice sheets to grow larger and lengthening the glacial cycle. Expansion of Antarctic ice sheets would have also contributed to increasing the salinity of southern source areas as Antarctica shifted from dominantly terrestrial melting to marine-based calving margins (Raymo et al., 2006). Our temperature and salinity reconstructions support a fundamental reorganization of the density structure and stratification of the abyssal glacial ocean across the Middle Pleistocene Transition.

References: