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Relatively warm deep-water formation persisted in the Last Glacial Maximum

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The Last Glacial Maximum (19–23 thousand years ago) was characterized by low greenhouse gas concentrations and continental ice sheets that covered large parts of North America and Europe. Glacial climate was therefore very different, with colder global mean temperatures and an increased Equator-to-pole temperature gradient, probably resulting in stronger westerlies. However, the state of the deep North Atlantic Ocean under these glacial climate forcings remains uncertain, particularly owing to the rarity of deep-ocean temperature and salinity constraints. Here we show that the temperature of the glacial deep (>1.5 km) Northwest Atlantic was approximately 0–2 °C (only 1.8 ± 0.5 °C (2 s.e.) colder than today), and, after accounting for the whole-ocean change, seawater $\delta^{18}O$ was 0.3 ± 0.1‰ (2 s.e.) higher and can be traced back to the surface subtropics via the subpolar Northeast Atlantic and Nordic Seas. Together, our hydrographic data reveal the thermal and isotopic structure of the deep Northwest Atlantic and suggest sustained production of relatively warm and probably salty North Atlantic Deep Water during the Last Glacial Maximum. Furthermore, our results provide updated constraints for benchmarking Earth system models used to project future climate change.