How did the Cryosphere Affect the North Atlantic Ocean During the Last Glacial Maximum?

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While some aspects of ocean circulation are understood, there are important unresolved questions worth answering. Due to ongoing climate change, one such question is the impact of melting ice on ocean circulation. Some research points to an impending tipping point by the end of this century, while studies documenting circulation changes must look to the past. There is a current gap in understanding the connection between the cryosphere, climate, and deep ocean in the North Atlantic Ocean –something which has implications for future climate models. Therefore, reconstructing these relationships during past intervals such as the Last Glacial Maximum (LGM) is important in helping to determine the role that the melting of the Laurentide Ice Sheet had in influencing climate change, including the transition to the current Holocene environment. Studies have supported that ocean circulation changes occurred during the LGM, but the causal connection remains unclear, as it is uncertain whether change in climate or ocean circulation occurred first. It is thought that abundant icebergs and consequent freshwater flux reverses the Atlantic Meridional Overturning Circulation, which drives northward heat transport as it produces cold, salty deep water in the North Atlantic, and could create positive feedback to diminish North Atlantic Deep Water production and the associated regional warming influence. Therefore, were icebergs produced by a warming climate or did icebergs drive climate change by weakening ocean circulation? To reconstruct the cryosphere during the LGM in the North Atlantic, two proxies are used: the ratio of oxygen isotopes ($\delta^{18}O$) within foraminifera fossils and ice-rafted debris (IRD) counts from the IODP Site U1313 (41°0.07′N, 32°57.44′W; water depth of 3426m) in the central North Atlantic Ocean. *N. incompta* are abundant in surface waters and record a $\delta^{18}O$ signal sensitive to temperature changes. *T. quinqueloba* are sensitive to salinity in cold waters, so *T. quinqueloba* $\delta^{18}O$ record salinity changes as icebergs melt and introduce freshwater at the surface. IRD is counted to investigate the activity of icebergs and identify Heinrich Events. When joined with deep ocean and climate proxy data from this site during the LGM, the question of timing can be addressed.