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Controls on oxygen concentrations and $\delta^{13}C$ in the glacial Atlantic

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Oxygen concentrations in seawater are sensitive to both changes in carbon storage and surface processes that set the preformed oxygen concentrations of different water masses. New and developing oxygen proxies have led to (semi-)quantitative estimates of glacial oxygen concentrations, which suggest the glacial deep Atlantic had ~50 umol/kg lower oxygen than in the Holocene. However, the water depth structure of oxygen concentrations in the past is poorly constrained, and so attribution of oxygen variability to specific water masses and parsing the potential role of preformed variability is difficult. In this study, we present the most highly resolved depth transect of glacial oxygen concentrations, which comes from the western tropical Atlantic at the Demerara Rise (7-9˚N, 53-54˚W, 350 to 2550 m water depth). We use the novel quantitative proxy U/Ba to generate oxygen reconstructions in a setting where the foraminifera needed for $Dd^{13}C$, the only other feasible proxy, are rare. Glacial oxygen content along the Demerara Rise was consistently lower than modern, with the largest change (~100 umol/kg) occurring at 1500-2500 m water depth. We combine these new oxygen reconstructions with published data to optimize an endmember mixing model that provides estimates of the preformed $d^{13}C$ and oxygen content of three water masses in the Atlantic Ocean. Contrasting with glacial model simulations, our results suggest lower oxygen concentrations throughout the depth range of our cores, which we suggest was predominately driven by lower preformed oxygen in Antarctic Intermediate Water and North Atlantic Deepwater.