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A weaker Atlantic Meridional Overturning Circulation at the Last Glacial Maximum led to a greater deep ocean carbon content

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While paleoproxy records and modelling studies consistently suggest that North Atlantic Deep Water (NADW) was shallower at the Last Glacial Maximum (LGM) than during pre-industrial times, its strength is still subject to debate partly due to different signals across the North Atlantic. Here, using a series of LGM experiments performed with a carbon isotopes enabled Earth system model, we show that proxy records are consistent with a shallower and weaker NADW. A significant equatorward advance of sea-ice over the Labrador Sea and the Nordic Seas shifts the NADW convection sites to the south of the Norwegian Sea. While the deep western boundary current in the Northwest Atlantic weakens with NADW, a change in density gradients strengthens the deep southward flow in the Northeast Atlantic. A shoaling and weakening of NADW further allow penetration of Antarctic Bottom Water in the North Atlantic despite its transport being reduced. This resultant globally weaker oceanic circulation leads to an increase in deep ocean carbon of ~500 GtC, thus significantly contributing to the lower LGM atmospheric CO_2 concentration.