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Cold-water corals in the Subpolar North Atlantic Ocean exposed to aragonite undersaturation if Paris 2 ºC is not met

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The uptake of carbon dioxide (CO_2) from the atmosphere is changing the ocean's chemical state. Such changes, commonly known as ocean acidification, include reduction in pH and the carbonate ion concentration ($[CO_3^{2-}]$), which in turn lowers oceanic saturation states (Ω) for calcium carbonate ($CaCO_3$) minerals. The Ω values for aragonite ($\Omega_{aragonite}$; one of the main $CaCO_3$ minerals formed by marine calcifying organisms) influence the calcification rate and geographic distribution of cold-water corals (CWCs), important for biodiversity. In this work we use high-quality data of inorganic carbon measurements, collected on thirteen cruises along the same track during 1991–2018, to determine the long-term trends in $\Omega_{aragonite}$ in the Irminger and Iceland Basins of the North Atlantic Ocean, providing the first trends of $\Omega_{aragonite}$ in the deep waters of these basins. The entire water column of both basins showed significant negative $\Omega_{aragonite}$ trends between -0.0015 ± 0.0002 and -0.0061 ± 0.0016 per year. The decrease in $\Omega_{aragonite}$ in the intermediate waters, where nearly half of the CWC reefs of the study region are located, caused the $\Omega_{aragonite}$ isolines to migrate upwards rapidly at a rate between 6 and 34 m per year. The main driver of the observed decline in $\Omega_{aragonite}$ in the Irminger and Iceland Basins was the increase in anthropogenic CO_2. But this was partially offset by increases in salinity (in Subpolar Mode Water), enhanced ventilation (in upper Labrador Sea Water) and increases in alkalinity (in classical Labrador Sea Water, cLSW; and overflow waters). We also found that water mass aging reinforced the $\Omega_{aragonite}$ decrease in cLSW. Based on the observed $\Omega_{aragonite}$ trends, we project that the entire water column of the Irminger and Iceland Basins will likely be undersaturated for aragonite when in equilibrium with an atmospheric mole fraction of CO_2 (xCO_2) of ~860 ppmv, corresponding to climate model projections for the end of the century based on the highest CO_2 emission scenarios. However, intermediate waters will likely be aragonite undersaturated when in equilibrium with an atmospheric xCO_2 of ~600 ppmv, an xCO_2 level slightly above that corresponding to 2 ºC warming, thus exposing CWCs inhabiting the intermediate waters to undersaturation for aragonite.