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

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The uptake of carbon dioxide (CO<sub>2</sub>) 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<sub>3</sub><sup>2-</sup>]), which in turn lowers oceanic saturation states ( $\Omega$ ) for calcium carbonate (CaCO<sub>3</sub>) minerals. The  $\Omega$  values for aragonite ( $\Omega_{\text{aragonite}}$ ; one of the main CaCO<sub>3</sub> 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  $\Omega_{\text{aragonite}}$  in the Irminger and Iceland Basins of the North Atlantic Ocean, providing the first trends of  $\Omega_{\text{aragonite}}$  in the deep waters of these basins. The entire water column of both basins showed significant negative  $\Omega_{\text{aragonite}}$  trends between  $-0.0015 \pm 0.0002$  and  $-0.0061 \pm 0.0016$  per year. The decrease in  $\Omega_{\text{aragonite}}$  in the intermediate waters, where nearly half of the CWC reefs of the study region are located, caused the  $\Omega_{\text{aragonite}}$  isolines to migrate upwards rapidly at a rate between 6 and 34 m per year. The main driver of the observed decline in  $\Omega_{\text{aragonite}}$  in the Irminger and Iceland Basins was the increase in anthropogenic CO<sub>2</sub>. 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  $\Omega_{\text{aragonite}}$  decrease in cLSW. Based on the observed  $\Omega_{\text{aragonite}}$  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<sub>2</sub> (xCO<sub>2</sub>) of ~860 ppmv, corresponding to climate model projections for the end of the century based on the highest CO<sub>2</sub> emission scenarios. However, intermediate waters will likely be aragonite undersaturated when in equilibrium with an atmospheric xCO<sub>2</sub> of ~600 ppmv, an xCO<sub>2</sub> level slightly above that corresponding to 2 °C warming, thus exposing CWCs inhabiting the intermediate waters to undersaturation for aragonite.