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Ocean acidification trends in the North Atlantic: strength and controlling mechanisms

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The global ocean has absorbed ∼30% of the CO_2 emitted to the atmosphere by human activities (anthropogenic CO_2, C_{ant}) between 1750 to the present day. The highest C_{ant} storage rates have been found in the subpolar North Atlantic. It is very likely that such accumulation causes chemical changes in seawater CO_2 chemistry in this region. Repeated hydrographic sections provide critically needed data and understanding about changes in the basin-wide seawater CO_2 chemistry over multi-decadal timescales. Here, high-quality measurements collected at thirteen cruises carried out along the same track between 1981 and 2015 have been used to determine long-term chemical changes in seawater CO_2 chemistry and ocean acidification (OA) in the Irminger and Iceland basins of the North Atlantic Ocean. Trends were determined for each of the main water masses of the region and are discussed in the context of the basin-wide circulation. The pH has decreased in all water masses present in the Irminger and Iceland basins, with greatest changes in surface and intermediate waters (up to -0.0015 $\pm$ 0.0002 pH units·yr^{-1} in surface waters and up to -0.0013 $\pm$ 0.0002 pH units·yr^{-1} in intermediate waters). In order to disentangle the drivers of the pH changes, we decomposed the trends into their principal components: changes in temperature, salinity, total alkalinity (A_T) and total dissolved inorganic carbon (both its natural and anthropogenic components). The C_{ant} increase was identified as the main agent of the pH decline, partially offset by A_T increases. The acidification of intermediate waters caused by C_{ant} uptake has been reinforced by the aging of these water masses over the period of our analysis. The pH decrease of the deep overflow waters of the Irminger basin was similar to that observed in the upper ocean, and was mainly linked to the C_{ant} increase, thus reflecting the recent contact of these deep waters with the atmosphere.