Measuring ocean uptake of anthropogenic CO_2 in the Southeastern Indian Ocean: Changes in the ^{13}C Suess effect over the last decade

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Global utilization of fossil fuels is rapidly increasing atmospheric CO_2 concentrations and reducing (depleting) the atmospheric carbon isotopic signature, a phenomenon known as the ^{13}C Suess effect. The world's oceans are major carbon reservoirs with rapid timescales of ocean-atmosphere exchange. The Southern Ocean (SO) is a critical region for ocean-atmosphere gas exchange: with less than 30% of the global ocean surface area, models estimate it accounts for more than 40% of anthropogenic CO_2 uptake. The rate of CO_2 uptake by the ocean can be estimated by measuring changes in the $\delta^{13}C$ of dissolved inorganic carbon (DIC) over a known period of time. For this study, water samples were collected in November-December 2018 on the CROCCA-2S (Coring to Reconstruct Ocean Circulation and Carbon Dioxide Across 2 Seas) cruise. The $\delta^{13}C$ of DIC in the Southeastern Indian Ocean and SO was calculated using a multiparameter linear regression and compared to the CLIVAR (Climate and Ocean – Variability, Predictability and Change) program data from 2007-2009. Across this time period the surface ocean $\delta^{13}C_{DIC}$ decreased by up to 0.73 ±0.2 ‰ or 0.073±0.02‰ year^{-1}. This is a 0.01-0.025‰ year^{-1} increase in the of rate of change compared to the rate observed between 1994/95 and 2007-09 in the same region. Decreases were also detected down to depths of ~1800m. Thus, anthropogenic impacts extend to shallow interior water masses such as Subantarctic Mode Water (SAMW) and Antarctic Intermediate Water (AAIW) that form in the northern portion of the SO in the region of this study. SAMW and AAIW contribute to the upper limb of subsurface thermohaline circulation and laterally transport waters ventilated in the SO to upwelling zones at lower latitudes. The majority of our observed increase in subsurface CO_2 uptake occurred within SAMW, which has implications for the future carbon balance when these waters are upwelled in lower latitudes in the coming decades.