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Transient Tracers and Anthropogenic Carbon in Central Labrador Sea: a Multi-Decadal Study

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Over the last thirty years the Bedford Institute of Oceanography (BIO) has been maintaining the Atlantic Zone Off-Shore Monitoring Program (AZOMP), which includes annual occupation of several sections and stations in the Northwest Atlantic Ocean. Among these, the AR7W line across the Labrador Sea has one of the longest time-series where both transient tracers and dissolved inorganic carbon (DIC) have been collected since the early 1990s.

Among multiple transient tracers that have been measured along this transect (CFC-11, CFC-113, CCl₄ and SF₆), only measurement of CFC-12 extends over the full time-series from 1992 to 2018, overlapping with DIC observations. Measurements of CFC-12 were also available for a previous cruise in 1986, extending the time-series to three decades.

In this work we present the temporal variability of CFC-12 (1986-2016) and DIC (1992-2016) concentrations as well as their distribution in the major water masses of the region.

The CFC-12 data are used to reconstruct the time-history of the tracer's saturation at the time of convection based on multiple regression with the atmospheric input function of CFC-12 and the annual maximum mixed layer depth. The so-modelled time-varying saturation is employed to relax the constant saturation assumption of the Transit Time Distribution (TTD) method, allowing for a better estimate of anthropogenic carbon (C_{ant}) in the region.

We present the column inventories and storage rate of C_{ant} in central Labrador Sea between 1986 and 2016 obtained using the TTD method with time-varying saturation. We compare these estimates with a classical TTD approach that assumes constant saturation, and we highlight the differences in trends and magnitudes obtained with the two approaches.

Finally, our work shows the multi-decadal dataset of DIC in the Labrador Sea which enables a comparison between the TTD-based C_{ant} estimates and the measured DIC trends, providing insights into temporal variability of natural carbon in the region.