Estimation of the increase in the anthropogenic carbon dioxide column inventory in the 137˚E section by the eMLR method

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The ocean absorbs approximately 30% of the carbon dioxide (CO_2) released into the atmosphere by human activities such as fossil fuel combustion and land-use changes, and is mitigating the progress of global warming. The western North Pacific subtropical zone is considered as one of the strong sinks of the anthropogenic CO_2 in the world oceans. It is important to evaluate the change in its column inventory in this area for the better understanding the global carbon cycle change, thereby better projection of the global warming. Japan Meteorological Agency has been carried out the atmospheric and oceanic CO_2 measurement along its repeat line at 137˚E every year since early 1980s. The WOCE/GO-SHIP's precise measurements with high-resolution and full water-column samplings have been made in the years 1994, 2010 and 2016. In this study, we evaluated the changes in the column inventory of the anthropogenic CO_2 in the 137˚E section based on the biogeochemical data collected in these cruises using the eMLR method (Friis et al. 2005). In our eMLR analysis, we used the relationship between salinity-normalized preformed DIC (nDIC*) and chemical tracer NO (Broecker, 1974).

nDIC* = {DIC −117/170 ·(O_2^{sat} −O_2)} ·35/*S*,

NO = O_2 + 170/16 ·NO_3^+ (Anderson and Sarmiento, 1994).

NO is preformed oxygen concentration calculated using nitrate concentration. It is a quasi-conservative tracer that does not change with biological activity in the same water mass.

nDIC* and NO are linearly correlated to each other below the winter mixed layer in the subtropical zone between 19˚N and 34˚N:

nDIC* = *a* + *b* ·NO.

In the tropics to the south of 18˚N, their relationships show non-linearity due to the north-south fluctuation of the North Equatorial Current and mixing with the water mass from the Southern Ocean. We then calculated the differences in nDIC* among three cruises in 1994, 2010 and 2016 in the subtropics between 19˚N and 34˚N using the difference in the slope *b* in the above equation, and integrated over the water column above σ_θ = 27.3 to estimate the column inventory of anthropogenic CO_2. The rates of increase in the anthropogenic CO_2 inventory were 0.83, 0.67 and 0.62 mol/m^2/year (preliminary) at 30˚N, 25˚N and 20˚N, respectively, for 22 years between 1994 and 2016, and 1.84, 1.57 and 1.44 mol/m^2/year (preliminary) at 30˚N, 25˚N and 20˚N, respectively, for 6 years between 2010 and 2016 (Fig. 1). The higher rate in the northern subtropics is attributable to the deeper ventilation (Fig. 2). It is also higher for the period from 2010 to 2016 than that from 1994 to 2016. We will also study in the different water masses such as those in the tropical zone and above the bottom of winter mixed layer where the relationship between nDIC* and NO shows non-linearity.

Keywords: anthropogenic CO2, 137˚E section, column inventory

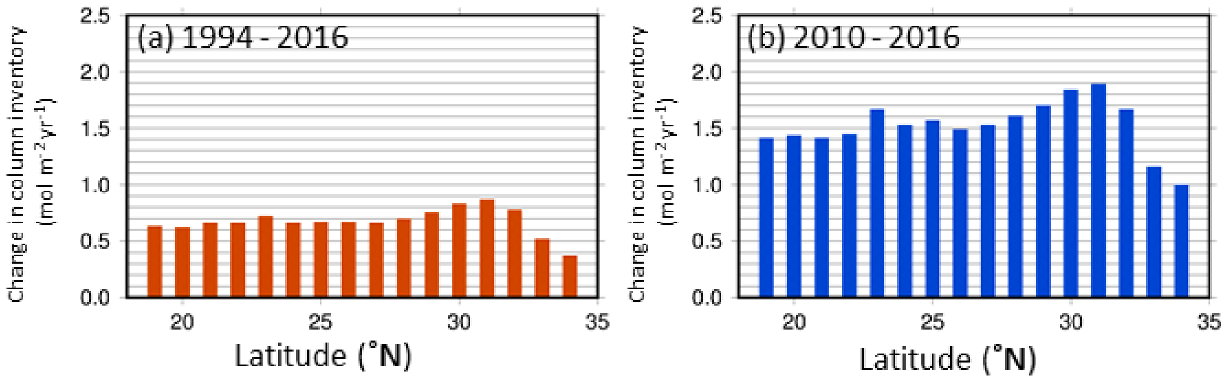

Fig. 1 Column inventory rates of anthropogenic CO2 along 137E between (a) 1994 and 2016 and (b) 2010 and 2016.

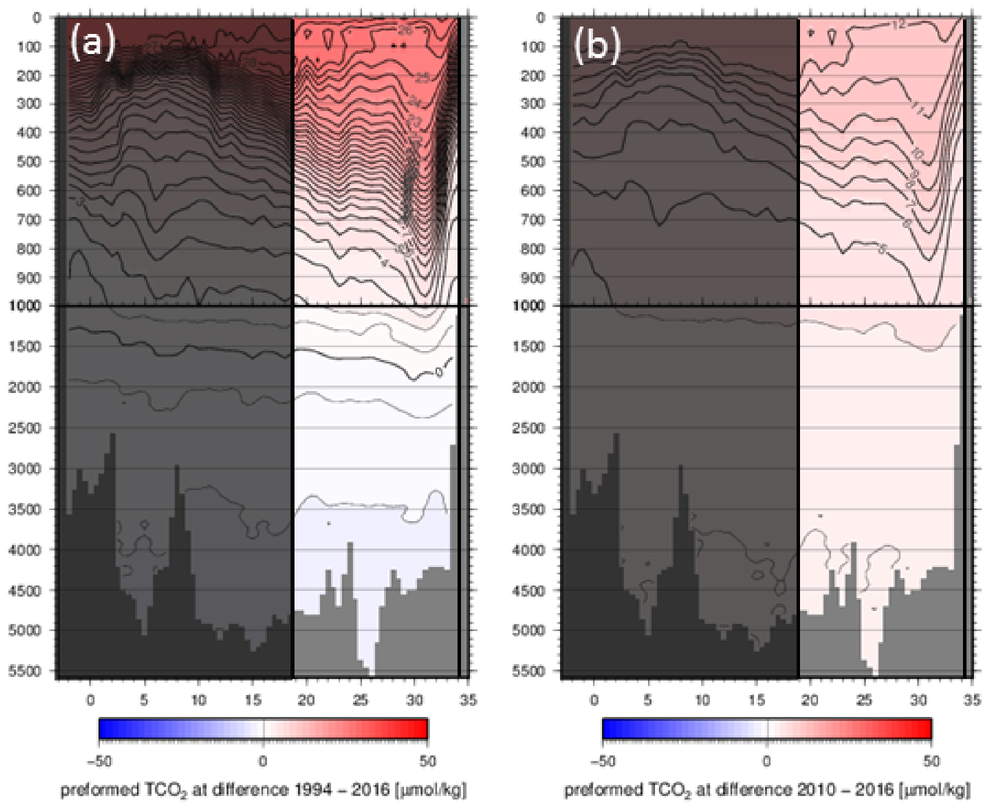

Fig. 2 Sections of anthropogenic CO_2 changes between (a) 1994 and 2016 and (b) 2010 and 2016. Gray colorings indicate areas outside the subtropical gyre.

