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A new approach for estimating anthropogenic carbon relying on an observational back-calculation method

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Around 31% of carbon dioxide derived from human activities (C_{anth}) has been absorbed by the ocean (DeVries, 2014; Gruber et al., 2019; Sabine et al., 2004). This accumulation helps to mitigate atmospheric carbon dioxide (CO_2), but in turn leads to severe consequences on marine systems (IGBP, IOC, SCOR, 2013). Both components of CO_2, i.e. anthropogenic and natural, present high variability and uncertainties difficult to observe and quantify. In particular, the C_{anth} signal represents a small fraction of the total dissolved inorganic carbon pool (C_T) and it is not directly distinguishable from the natural component, resulting in the emergence of back-calculation techniques (Brewer 1978; Chen and Millero, 1979) to derive it indirectly. Over the years, back-calculation techniques have undergone remarkable improvements (Gruber et al., 1996; Sabine et al., 2004; Touratier et al., 2004, 2007; Vázquez-Rodríguez et al., 2009a, 2009b, 2012), resulting in different methods for estimating C_{anth} that, despite providing helpful and advanced results, show various biases and limitations. Here, we present a new approach for estimating C_{anth} that relies on a back-calculation methodology, purely based on carbon data, and provides results that show good agreement with previous global C_{anth} climatologies. Our approach mainly differs from previous methodologies by pioneering using the transport matrix output from a data‐assimilating ocean circulation inverse model (TMI: Total Matrix Intercomparison; Gebbie and Huybers, 2010) to obtain preformed properties, instead of the historical use of Optimum Multiparameter analysis (OMP). This improvement prevents from the need to use (sub)surface-property linear regressions to estimate preformed alkalinity or air-sea CO_2 disequilibrium, and allows introducing different corrections for denitrification and, as a novelty, oxygen disequilibrium.