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Anthropogenic CO2 uptake, transport, storage, and dynamical controls in the ocean: a modeling study

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Using an ocean carbon cycle model embedded in an ocean general circulation model, we examine how the budget of anthropogenic CO2 is dynamically controlled. The budget is composed of transport, storage rate, uptake from the atmosphere, and density conversion. We estimate (1) vertically integrated budget, (2) three-layer budget, and (3) eleven-layer budget for the eleven sub-domain of the global ocean. This work is the first attempt to conduct the budget analyses in the density framework. The vertically integrated budget is appropriate for examining the inter-basin transport of the anthropogenic CO2. The estimated budget is largely consistent with the previous studies. The three-layer budget allows us to identify how the meridional overturning circulation related transport determines the thermocline inventories for anthropogenic CO2. It is found that Subtropical Cells and the thermohaline circulation play a fundamental role for the budget in the Pacific and Atlantic Oceans, respectively. Along with a inventory map in each isopycnal layer, the eleven-layer budget is suitable for examining how anthropogenic CO2 is stored and transported in various water masses. For the mode waters, which serve as reservoirs of anthropogenic CO2 accumulated in the ocean interior, it is found that uptake via gas exchange is important but much of the uptake via gas exchange occurs non-locally to the mode water formation regions through the Subtropical Cells

Keywords: anthropogenic carbon, OGCM, transport