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Decadal Trends in the Oceanic Storage of Anthropogenic Carbon from 1994 to 2014

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The oceanic sink for anthropogenic CO_2 (C_{ant}) that humans have emitted into the atmosphere has been pivotal for limiting global warming. The transport of C_{ant} from the surface into the ocean interior, where most of it is accumulating, is the rate limiting step for this uptake. Yet multi-decadal trends in the ocean interior storage of C_{ant} have not been assessed at global scale. We determined such trends by applying the eMLR(C*) regression method to ocean interior observations collected between 1989 and 2020, and found that the global ocean storage of C_{ant} grew by 29 ± 3 Pg C dec^{-1} and 27 ± 3 Pg C dec^{-1} (±1σ) from 1994 to 2004 and 2004 to 2014, respectively. Although the two growth rates are not significantly different, they imply a reduction of the oceanic uptake fraction of the anthropogenic emissions from 36 ± 4 % to 27 ± 3 % during the respective decades. We attribute this reduction to a decrease of the ocean buffer capacity and changes in ocean circulation. In the Atlantic Ocean, the maximum storage rate shifted from the Northern to the Southern Hemisphere, plausibly caused by a weaker formation rate of North Atlantic Deep Waters and an intensified ventilation of mode and intermediate waters in the Southern Hemisphere. Between 1994 and 2004, the oceanic C_{ant} accumulation exceeded the net air-sea flux by 8 ± 4 Pg C dec^{-1}, suggesting a loss of natural carbon from the ocean during this decade. Our results reveal a substantial vulnerability of the ocean carbon sink.