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# Simulated changes in Southern Ocean ventilation in the past 50 years driven by wind and buoyancy forcing

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Observations of $CO_2$ partial pressure at the Southern Ocean surface suggest pronounced decadal changes in ocean $CO_2$ uptake in the past several decades, but the underlying mechanisms are still not clear. A key process for the uptake of anthropogenic $CO_2$ is the ventilation of Subantarctic Mode Water (SAMW) and Antarctic Intermediate Water (AAIW). The aim of this study is to elucidate physical drivers of Southern Ocean ventilation since the 1950s by using an eddy-rich 1/4° ocean model containing CFC-12. Simulated CFC-12 is compared with observed interior distributions and is used as a proxy of ocean ventilation. We assess the role of changing atmospheric forcing for Southern Ocean ventilation by comparing CFC-12 inventories in four experiments: a climatological simulation (repeated-annual-cycle atmospheric forcing), a hindcast simulation (interannual forcing from 1948 to 2009), and two sensitivity simulations where the wind stress and buoyancy forcing are in turn climatological and interannual. The simulations show decreased ventilation until the 1980s and a subsequent increase until 2009. This multi-decadal fluctuation is the result of counteracting effects of increased wind stress and increased stratification. Whereas the increased wind stress and associated meridional overturning circulation leads to enhanced tracer uptake especially within AAIW density classes, increased stratification leads to a shift of ventilation towards SAMW. Significant regional differences exist among the Atlantic, Pacific and Indian basins mainly because of decadal fluctuations of the buoyancy forcing. By using a coupled ocean-biogeochemistry model, ongoing work is focused on evaluating whether the recent increase in ventilation may explain the observed increased Southern Ocean carbon sink since the early 2000s despite the continuing increase in upwelling of carbon-rich deep waters.