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The role of changing Southern Ocean circulation for the uptake and storage of CFC-12, anthropogenic CO2 and oxygen

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Recent studies highlighted an increase in the Southern Ocean ventilation since several decades and, at the same time, pronounced decadal fluctuations in its carbon sink. The role of changing ventilation for the anthropogenic CO_2 uptake (and thus for the overall Southern Ocean carbon sink) and for oxygen concentrations of mode and intermediate waters (with possible impacts on low-oxygen regions downstream) are still poorly understood. The aim of this study is to assess the role of changing Southern Ocean ventilation for the uptake and storage of atmospheric gases such as CFC-12, CO_2 and oxygen. A related question is whether CFC-12 can be used as a proxy of anthropogenic CO_2 in the Southern Ocean, since CO_2 equilibrates significantly more slowly in seawater than CFC-12 and, while the solubility of CFC-12 increases with decreasing temperature and salinity, the solubility of anthropogenic CO_2 decreases. We developed a suite of global configurations based on the NEMO-LIM2 ocean sea ice model including the passive tracer CFC-12 and the biogeochemical model MOPS. The suite includes ORCA05 (1/2° resolution), ORCA025 (1/4° resolution) and ORION10 (featuring a 1/10° nest between 68°S and 30°S). Hindcast and sensitivity experiments performed with ORCA025 under the JRA-55-do atmospheric forcing are used to unravel the role of changing wind and buoyancy forcing on the gas uptake and storage. First results highlight that anthropogenic CO_2 is taken up in lighter density classes than CFC-12, meaning that increased ventilation of lighter mode waters would be particularly effective in taking up anthropogenic CO_2. This effect is more pronounced in the higher-resolution model ORION10, indicating that mesoscale eddies inject anthropogenic CO_2 in lighter waters than lower-resolution models.

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