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How do the westerlies influence the Southern Ocean subduction of anthropogenic carbon?

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The Southern Ocean is responsible for roughly a third of the global oceanic anthropogenic carbon uptake, and this uptake occurs in the upper ocean Sub-Antarctic Mode Water (SAMW) and Antarctic Intermediate Water (AAIW) layers. The process by which the anthropogenic carbon is transported into the ocean interior is commonly known as 'subduction'. Observationally-based and model studies have shown that the subduction of SAMW and AAIW occurs in hot spots primarily in the deep mixed layer depths in the Indian and Pacific sectors of the Southern Ocean. Two key atmospheric changes in recent decades in the Southern Ocean are increases in atmosphere to ocean buoyancy input, and the poleward intensification of the westerly wind stress band. Both buoyancy and winds are drivers of the Southern Ocean large scale circulation, and in this study we diagnose the impact of specifically the westerly winds on the upper ocean subduction. We evaluate the mean and eddy subduction components under three sensitivity experiments where the westerlies are increased, shifted poleward, and both shifted and increased. We use a 1/4-degree eddy-permitting ocean-ice model coupled to a reanalysis atmosphere. Our perturbation experiments reveal that intensified winds enhance the deep mixed layer depths locally, but a shift in the westerlies decreases (increases) the mixed layer depth in the Indian (southeast Pacific) sector. A poleward intensification of the westerlies combines the individual shift and intensified wind experiment change, as well as strongly enhancing Atlantic mixed layers. The mixed layer changes are associated with SAMW and AAIW subduction, and we find that the poleward intensification of the westerlies overall enhances both the eddy and large scale subduction rates. Using our subduction results and observations, we infer regional anthropogenic carbon inventory changes in a water mass framework under wind stress changes.