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Multi-decadal decline in the formation of Antarctic Intermediate Water: a high-resolution model hindcast

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We investigate the spatial and temporal variability of Antarctic Intermediate Water (AAIW) formation rates, a process associated with substantial ocean uptake of heat and anthropogenic CO_2. To this end, we use a global configuration of the ocean general circulation model NEMO-LIM at 1/4° resolution (ORCA025) to perform a 60-year simulation forced with the CORE atmospheric reanalysis for the time period 1948-2007. A companion simulation forced by a repeated annual cycle of atmospheric forcing is used to correct for model spurious trends. The model is found to reproduce the main features of AAIW, despite being somewhat biased towards higher core densities through higher salinity and decreased northward propagation. The spatial distribution of AAIW formation rates is explored via available AAIW volume and via kinematic subduction rates. Maximum AAIW formation is found in the southeast Pacific and along the Antarctic Circumpolar Current fronts in the Pacific and Indian Ocean corresponding to mixed layer depth (MLD) winter maxima, whereas kinematic subduction rates are highest in regions dominated by lateral induction. Over the 1948-2007 period, the largest temporal trends in MLDs, AAIW formation rates and kinematic subduction rates are found in the southeast Pacific. Here, a strong negative MLD trend is accompanied by a decrease in salinity at the mixed layer base. Both AAIW formation rates and kinematic subduction rates show a similar decreasing trend in the southeast Pacific, superimposed to a strong interannual variability in the case of kinematic subduction rates. In the southwest Pacific, the negative trend is less pronounced, the Indian and Atlantic Ocean do not show any trend. However, interannual variability in the case of kinematic subduction rates is strong for all ocean basins.