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On the role of mesoscale eddies in the ventilation of Antarctic Intermediate Water

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The spatial distribution of Antarctic Intermediate Water (AAIW) formation and ventilation remains a matter of debate. Some studies suggest that AAIW forms nearly homogeneously in a circumpolar pattern, whereas others favor more localized formation particularly in the southeast Pacific Ocean. We show here that the patterns and magnitude of AAIW formation and ventilation are substantially affected by mesoscale eddies. To diagnose the role of eddies, we made global CFC-11 simulations in two versions of the ocean general circulation model OPA9, a "non-eddying", coarse-resolution version ($2^{\circ} cos\varphi \times 2^{\circ}$, ORCA2) and an "eddying" or eddy-permitting version ($\frac{1}{2}^{\circ} cos\varphi \times \frac{1}{2}^{\circ}$, ORCA05). In the noneddying simulation, AAIW subducts in a near homogeneous, circumpolar pattern; in the eddying simulation, the distribution of AAIW ventilation is patchier. Increasing resolution causes the AAIW layer to thin by 32% on average in the Indian sector, but only by 11% in the Pacific sector. This patchiness appears due to the zonal wind stress, which is weak over much of the Pacific and southwest Atlantic sectors but is strong over the Indian sector. Consequently, the effect of eddies is largest in the Indian Ocean, moderate in the Atlantic, and smallest in the Pacific basin. Although the Gent & McWilliams (GM) eddy parameterization improves the overall vertical structure of density in the Southern Ocean, applying it in our non-eddying model still results in the nearly uniform circumpolar distribution of AAIW ventilation, in contrast to the observations.