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The diffusive leakage of the lower limb of the AMOC

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The upper branch of the MOC, which is primarily in the Atlantic Ocean (AMOC), has largely been considered to be adiabatic in nature, i.e. water sinking in the North Atlantic finds its return pathway to the surface through the pivotal role of the wind in the Southern Ocean, with little or no interior cross-density mixing (diapycnal mixing). Recently there has been progress in understanding and highlighting the role of near boundary turbulence in diapycnal conversion of water masses. Motivated by this development, we investigate the extent to which diapycnal processes impact the global oceanic redistribution and storage of tracers through the AMOC. From a combination of Argo-based estimates of turbulent mixing in the upper 2000m, an observationally tuned theoretical/numerical global map of deep and abyssal turbulent mixing, and observationally-inferred basin-wide bulk estimates of turbulent mixing, we calculate the diffusive water mass transformation in the Atlantic Ocean in between the regions of sinking of waters in the Arctic and the upwelling zone in the Southern Ocean. Our main finding is that the diffusive processes can comfortably move tracers by a kilometer in the vertical in the Atlantic Ocean between 48°N and 32°S, which is sufficient to mix the tracer between abyssal and deep waters, or between deep and intermediate waters. Tracers that upwell in different density classes in the Southern Ocean will follow different corridors of the global ocean circulation, with crucial consequences for their global redistribution and ventilation timescale. Hence, the diffusive “leakage” of waters, as reported herein, plays a key role in setting the faith of tracers carried around by AMOC.