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Water masses transform at mid-depths over the Antarctic Continental Slope

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The Meridional Overturning Circulation (MOC) controls the oceans' latitudinal heat distribution, helping to regulate the Earth's climate. The Southern Ocean is the primary place where cool, deep waters return to the surface to complete this global circulation. While water mass transformations intrinsic to this process predominantly take place at the surface following upwelling, recent studies implicate vertical mixing in allowing transformation at mid-depths over the Antarctic continental slope. We deployed an EM-Apex float near Elephant Island, north of the Antarctic Peninsula's tip, to profile along the slope and use potential vorticity to diagnose observed instabilities. The float captures direct heat exchange between a lens of Upper Circumpolar Deep Water (UCDW) and surrounding Lower Circumpolar Deep Waters (LCDW) at mid-depths and over the course of several days. Heat fluxes peak across the top and bottom boundaries of the UCDW lens and peak diffusivities across the bottom boundary are associated with shear instability. Estimates of diffusivity from shear-strain finestructure parameterisation and heat fluxes are found to be in reasonable agreement. The two-dimensional Ertel potential vorticity is elevated both inside the UCDW lens and along its bottom boundary, with a strong contribution from the shear term in these regions and instabilities are associated with gravitational and symmetric forcing. Thus, shear instabilities are driving turbulent mixing across the lower boundary between these two water masses, leading to the observed heat exchange and transformation at mid-depths over the Antarctic continental slope. This has implications for our understanding of the rates of upwelling and ocean-atmosphere exchanges of heat and carbon at this critical location.