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Onshore diffusion of Circumpolar Deep Water

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Warm, salty Circumpolar Deep Water (CDW) has long been regarded as the climatological driver for Antarctica, but the mechanism of how it can reach the continental shelf remains unsettled. Motivated by the absence of observational eddy flux estimation in the Antarctic margin, we quantify isopycnal diffusivity of CDW by hydrographic records and satellite altimetry under the mixing length framework. For comparison, spiciness and thickness are used as the isopycnal tracer, and two yield similar results. Over the extent of Antarctic Circumpolar Current (ACC), we find a general agreement with the mixing suppression theory and its exception in the lee of the topography as previously reported. In contrast, no mixing length's dependency on mean flow is obtained to the pole, reflecting a stagnant flow regime in the Antarctic margin. Isopycnal diffusivity ranges 100–500 m^2 s^{-1} to the south of the ACC. Eddy diffusion is likely enhanced where the CDW intrusion is localized by the recirculating gyres, mostly attributable to the small gradient of isopycnal thickness. Volume transport is then estimated by the layer thickness gradient. Thickness-diffusive onshore heat flux across the continental slope (~3.6/1.2 TW in the eastern/western Indian sectors) is quantitatively consistent with cryospheric heat sinks by sea ice formation and ice shelf basal melt, suggesting that the isopycnal eddy diffusion is the main cause of the onshore CDW intrusion. We emphasize that the thickness field is essential for determining the eddy fluxes in the Antarctic margin.