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Deep Meridional Circulation in the Southern Ocean is Topographically Controlled

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The Southern Ocean fundamentally influences the Earth's climate through it's strong control over the deep meridional circulation. This circulation moves vast amounts of mass, heat and tracers, acting to redistribute them throughout the global ocean. However, due to its complex dynamics and a lack of observations, the Southern Ocean's deep circulation is poorly understood.

We present a new interpretation of the deep circulation by using a network of Lagrangian autonomous floats to derive the first observation-based maps of the deep meridional flow. Contrary to most existing studies that employ a quasi 2-dimensional framework, we find fluxes are strongly localised near large topographic features, with alternating northward and southward fluxes effectively cancelling each other, leaving a small residual that contributes to the total flux. A simple force-balance indicates that the dynamics that give rise to these fluxes occur due to steering of the large-scale Antarctic Circumpolar Current by the bottom topography.

Finally, we discuss the implications of this work, noting that strongly localised fluxes which yield a small yet important net meridional flux, will influence the redistribution of heat and tracers within and between ocean basins, water mass transformation and the deep storage of CO_2.