Residual-mean circulation of the Leeuwin Current System in an eddy-resolving general circulation model

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The Leeuwin Current (LC) flows poleward along the west coast of Australia in the depth range 0-200 m and the Leeuwin Undercurrent (LUC) flows equatorward below the LC in 200-800 m. In the latitude range of Australia, the near-surface geostrophic flow is generally eastward in the southeastern Indian Ocean. A previous geostrophic calculation on a gridded hydrographical climatology indicated that the eastward flow feeds into the LC, sinks to the top of the LUC, and flows offshore out of the LUC, forming a zonal-vertical overturning. In the present study, a 20-year timeseries of 3-day snapshots from an eddy-resolving ocean general circulation model is used to construct an isopycnal-diapycnal view of this overturning.

In most of the LC depth range, the eastward flow that joins the LC and flows poleward becomes denser presumably because of surface cooling and then either flows westward out of the LC or goes around the southwest corner of Australia. Near the bottom of the LC depth range, the eastward-flowing water moves downward along the sloping isopycnal, joins the top of the LUC, and flows further down along the isopycnal. In the LUC depth range, the eastward flow joins the LUC, flows isopycnally equatorward, but eventually all water turns offshore and the LUC vanishes by 22S. Diapycnal volume transport contributes little to the downward motion except in the upper part of the LC.

The mean diapycnic volume flux is equal to the horizontal divergence of the "residual mean flow", which is the sum of the eddy-induced (or "bolus") and Eulerian-mean isopycnal transports. Although the eddy-induced transport is much smaller than the Eulerian-mean one, the horizontal divergence of the former is comparable in magnitude to that of the latter and almost cancels out the latter, leaving little diapycnic flux.

Keywords: diapycnal flux, isopycnal flow, overturning, eddy-induced flow, coastal currents, interaction with interior

Shifted Composite