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Diagnosing the Influence of Mesoscale Eddy Fluxes on the Deep Western Boundary Current in the 1/10° STORM / NCEP Simulation

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Making use of a 0.1-degree ocean model, we establish a consistent picture of the interaction of mesoscale eddy density fluxes with the geostrophic deep western boundary current (DWBC) in the Atlantic between 26°N and 20°S. Above the DWBC core (defined as the level of maximum southward flow, $\sim$ 2000 m depth), eddies flatten isopycnals and thus decrease the potential energy of the mean flow, which agrees with their interpretation and parametrization in the Gent-McWilliams framework. Below the DWBC core, even though the eddy fluxes have a weaker magnitude, they systematically steepen isopycnals and hence feed potential energy to the mean flow. This contradicts common expectations. We find the two vertically separated eddy regimes through an analysis of the eddy density flux divergence in stream-following coordinates. In addition, pathways of potential energy in terms of the Lorenz energy cycle reveal the regime shift. The two-fold eddy effect on density is balanced by an overturning in the plane normal to the DWBC. Its direction is clockwise (with upwelling close to the shore and downwelling further offshore) north of the equator. In agreement with the sign change in the Coriolis parameter, the overturning changes direction to anti-clockwise south of the equator. Within the domain covered, except in a narrow band around the equator, this scenario is robust along the DWBC.