Boundaries of the Peruvian Oxygen Minimum Zone shaped by coherent mesoscale dynamics

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Dissolved oxygen in sea water is a major factor affecting marine habitats and biogeochemical cycles. Oceanic zones with oxygen deficits represent significant portions of the area and volume of the oceans and are thought to be expanding. The Peruvian oxygen minimum zone is one of the most pronounced and lies in a region of strong mesoscale activity in the form of vortices and frontal regions, whose effect in the dynamics of the oxygen minimum zone is largely unknown. Here, we study this issue from a modeling approach and a Lagrangian point of view, using a coupled physical-biogeochemical simulation of the Peruvian oxygen minimum zone and finite-size Lyapunov exponent fields to understand the link between mesoscale dynamics and oxygen variations. Our results show that, at depths between 380 and 600 meters, mesoscale structures have a relevant dual role. First, their mean positions and paths delimit and maintain the oxygen minimum zone boundaries. Second, their high frequency fluctuations entrain oxygen across these boundaries as eddy fluxes that point towards the interior of the oxygen minimum zone and are one order of magnitude larger than mean fluxes. We conclude that these eddy fluxes contribute to the ventilation of the oxygen minimum zone.