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# Old and cold contributions to the oxygen minimum zones

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Oxygen minimum zones (OMZs) are oxygen-poor layers in the water column of great importance for marine ecosystems and biogeochemical processes. The position, size and extent of the OMZs are set by the source water properties, transport timescales, as well as respiration, both upstream of and within OMZs. Here we use an adjoint ocean circulation model built upon observations of ocean tracers to explore the complex interplay between chemical, biological and physical processes. Specifically, we determine the contributions of different water masses to the volume and oxygen deficiency of the OMZs. Among the tracers used, phosphate, oxygen and radiocarbons are included. These allow to first, constrain the ocean circulation and its timescales, and second, to determine where in the ocean oxygen utilization takes place. Here we show that the OMZs are ventilated at a wide range of timescales, ranging from a few years from adjacent regions in the tropics and subtropics, to more than 3000 years from distant deep water formation areas. Preliminary results suggest that the Antarctic marginal seas are key source water regions. While the fraction of water volume that originates in the Ross and Weddell Sea is relatively low (~20-30%), the contribution to the OMZs oxygen deficit is as large as ~40%, i.e., 40% of the apparent oxygen utilization is associated with these waters. This is a consequence of the long transit times involved, about 3000 years. Our results stress the importance of the contributions of the Ross and Weddell Seas to the climate sensitivity of the OMZs.