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Dynamics of oxygen depletion in the nearshore of a coastal embayment of the southern Benguela upwelling system

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Abstract

Acquisition of high resolution time series of water column and bottom dissolved oxygen (DO) concentrations inform the dynamics of oxygen depletion in St Helena Bay in the southern Benguela upwelling system at several scales of variability. The bay is characterized by seasonally recurrent hypoxia (<1.42 ml l^{-1}) associated with a deep pool of oxygen-depleted water and episodic anoxia (<0.02 ml l^{-1}) driven by the nearshore (<20 m isobath) decay of red tide. Coastal wind forcing influences DO concentrations in the nearshore through its influence on bay productivity and the development of red tides; through shoreward advection of the bottom pool of oxygen-depleted water as determined by the upwelling-downwelling cycle; and through its control of water column stratification and mixing. A seasonal decline in bottom DO concentrations of _1.2 ml l^{-1} occurs with a concurrent expansion of the bottom pool of oxygen depleted water in St Helena Bay. Upwelling of this water into the nearshore causes severe drops in DO concentration (<0.2 ml l^{-1}), particularly during end-of-season upwelling, resulting in a significant narrowing of the habitable zone. Episodic anoxia through the entire water column is caused by localized degradation of red tides within the confines of the shallow nearshore environment. Oxygenation of the nearshore is achieved by ventilation of the water column particularly with the onset of winter mixing. No notable changes are evident in comparing recent measures of bottom DO concentrations in St Helena Bay to data collected in the late 1950s and early 1960s.