Dynamics of the oxygen minimum zone on the Namibian shelf: a model perspective

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We consider the sources and sinks of the oxygen cycle in the northern Benguela Upwelling System (BUS) off Namibia. A coupled hydrodynamic and biogeochemical ecosystem model integrated over a decade is used to analyse the specific contributions of the relevant physical and biogeochemical processes to the regional oxygen budget. On the Namibian shelf, upwelling of nutrient rich water fuels primary production and hence oxygen evolution in the euphotic zone. Mineralisation of sinking organic matter maintains steep oxygen gradients. Benthic, chemolithoautotrophic sulfur bacteria keep the redoxcline confined to the sediment and minimise the release of hydrogen sulfide into the water column. The model results show that the poleward undercurrent significantly modulates the biogeochemical cycling of organic matter on the shelf by advection of additional nutrients and oxygen depleted water. Furthermore, vertical migration of zooplankton in response to the oxygen conditions in the water column can act as a positive feedback, which may even prevent a fast deoxygenation of suboxic waters. The net effect of upwelling on the regional oxygen budget can be seen from calculated oxygen surface fluxes. The northern BUS reveals as a net oxygen source to the atmosphere. However, biologically most active areas, like the Kunene upwelling cell, are areas of oxygen uptake by the ocean. This is surprising considering the high primary production which would suggest an oxygen surplus. Finally, we could show that an ecosystem model of moderate complexity is able to describe the oxygen dynamics in an Eastern Boundary Upwelling System.