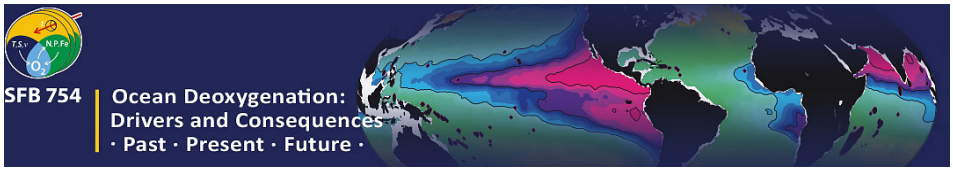

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Past variability and recent trends of subsurface ocean oxygenation in the Eastern Tropical South Pacific: insights from proxy records

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The Eastern Tropical South Pacific (ETSP) oxygen minimum zone (OMZ) is one of the largest regional OMZs in the global ocean. At multidecadal to millennial scales, the intensity and extension of this OMZ is modulated by changes of the Walker circulation, which control the thermocline depth –and thus productivity and respiration– in the ETSP, as well as the subsurface ventilation associated to the equatorial currents. Further south, the OMZ is also influenced by the meridional shifts of the subtropical front and by the intensity of the South Pacific Subtropical High (SPSH), which control the ventilation at higher latitudes and the alongshore wind forcing, respectively. Here we review a number of sedimentary proxy records that have been studied to reconstruct past variations of this OMZ under climate variability, in order to gain insights of the OMZ response to past global warm periods and this its potential sensitivity to current and future global warming. After the Last Glacial Maximum, a rapid deoxygenation process took place following the Southern Hemisphere signature of the deglaciation warming, leaving a distinct imprint in d15N sediment records along the Peru-Chile margin, up to maximal values during Heinrich Stadial 1. Thereafter, an average positive trend of oxygenation characterized the late deglaciation, overimposed with millennial fluctuations. A weaker OMZ during the warm mid-Holocene, as inferred by multiple proxies in the Peruvian slope, has been attributed to the intensification of the eastward subsurface equatorial currents and the poleward undercurrent, ultimately as a consequence of a much stronger Walker circulation. For the late Holocene, proxy records of oxygenation and productivity have evidenced significant shifts at multi-centennial time-scales, associated to global 'cold' and 'warm' climatic periods. Thus, for the Little Ice Age (LIA, 1400-1850 AD), proxy records off Peru and Northern Chile indicate an increased oxygenation in the water column and lower export production, under both weak Walker circulation and SPSH conditions. By contrast, for the late Medieval Climatic Anomaly (MCA, 1100 – 1350 AD) and after the LIA, the records report an increase in subsurface deoxygenation and a higher export production, while the Walker circulation and SPSH intensified. For the twentieth century, in the subtropical region, several shelf/slope records suggest an increased subsurface and bottom oxygenation with lower export production. At lower latitudes, a slight oxygenation is noticeable for the last half century that seems decoupled from increased export production. It needs to be elucidated in what extent the recent oxygenation trend could be explained by enhanced advection of the more oxygenated subsurface equatorial waters, lower productivity and respiration, increased northward advection of oxygen-rich subsurface and intermediate waters from the south and/or other mechanisms.

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