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TITLE: Multidecadal Changes in Marine Subsurface Oxygenation Off Central Peru During the Last ca. 170 Years

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ABSTRACT:

Subsurface water masses with permanent oxygen deficiency (oxygen minimum zones, OMZ) are typically associated with upwelling regions and exhibit a high sensitivity to climate variability. Over the last decade, several studies have reported a global ocean deoxygenation trend since 1960 and a consequent OMZ expansion. However, some proxy records suggest an oxygenation trend for the OMZ over the margins of the Tropical North East Pacific since ca. 1850. At the Tropical South East Pacific, the upper Peruvian margin is permanently impinged by a shallow and intense OMZ. In this study, we aim to 1) reconstruct the (multi)decadal oxygenation variability off central Peru, and 2) to identify the influence of both largescale and local factors and the potential underlying mechanisms driving subsurface oxygenation in the Eastern Pacific. We combined a multiproxy approach in multiple paleoceanographic records for the last ~170 years with instrumental records of subsurface oxygen concentrations since 1960. We analyzed benthic foraminiferal assemblages, redox-sensitive metals (Mo, Re, U),  $\delta^{15}\text{N}$  and contents of total organic carbon and biogenic silica in multiple sediment cores collected in the upper margin off Callao (180 m) and Pisco (~300 m). An OMZ weakening over the Peruvian central margin can be inferred from 1865 to 2004. The records can be divided in three major periods, based on responses of local productivity and subsurface ventilation: i) the mid to late nineteenth century, with enhanced siliceous productivity, a strong oxygen-deficient and reducing sedimentary conditions; ii) the late nineteenth century to mid-twentieth century, with less oxygen-deficient and reducing sedimentary conditions, superimposed to a slight decadal-scale variability; and iii) the late twentieth century until the early 2000's, with a slight oxygenation trend. We attribute the centennial-scale oxygenation trend in the Tropical East Pacific to ventilation processes by undercurrents that decreased subsurface oxygenation even when during the same period an overall increase in export production was inferred off Peru. Unlike other upwelling areas in the Tropical East Pacific, subsurface oxygenation off Peru does not show a decrease in the last decades, instead a subtle oxygenation trend was observed close to the core of the OMZ at 200 m depth.

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