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Below mesopelagic oxygen deficit layers: gradients of particle acoustic backscattering and oxygen.

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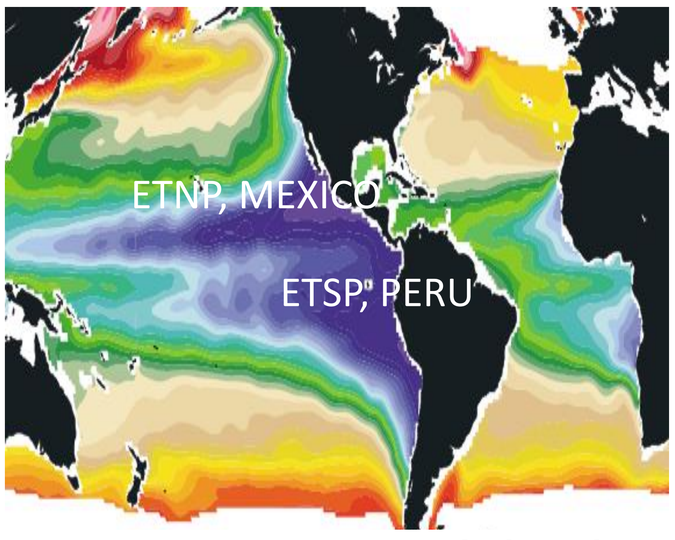
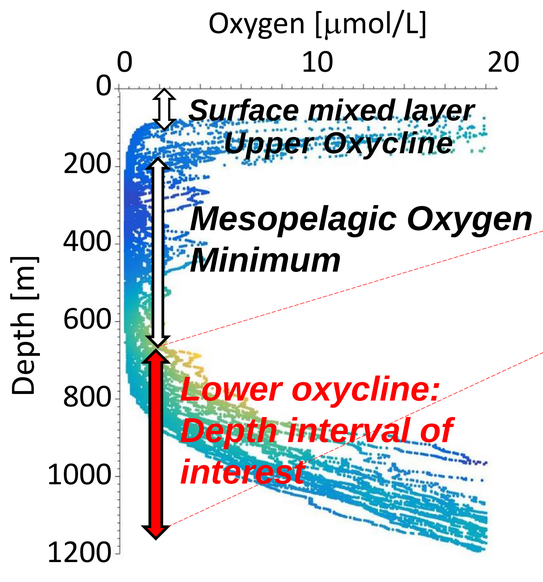
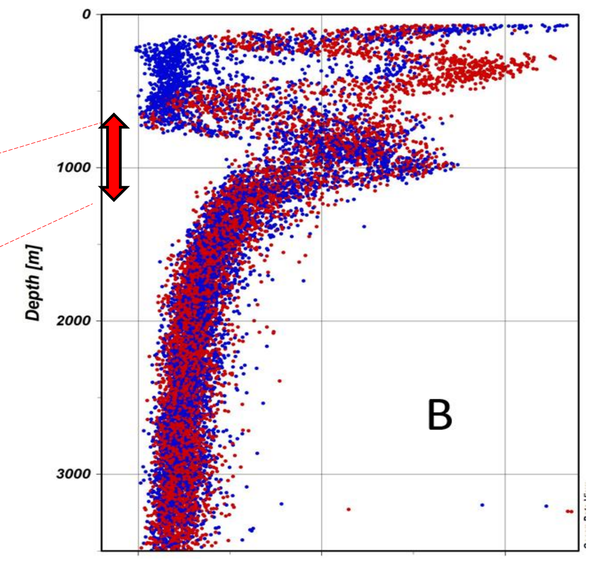
We compared acoustic backscatter profiles obtained by lowered ADCPs (300 kHz) below mesopelagic oxygen deficit layers (ODL) in the Eastern Tropical North and South Pacific ETNP, ETSP) finding recurrent patterns. We assume that the acoustic echo strength is proportional to metazoan concentration, The metazoans shows a well-defined peak below the lower oxycline of the ODLs a maximum at oxygen concentrations of less than 5 µmol/L. Below the echo strength peak the echo strength decreases rapidly. We assume the zooplankton biomass is maintained in a proportional manner by organic particle flux if there is no vertical migration of zooplankton. Thus, there should be proportionality between acoustic backscatter and the organic particle flux at a given depth. We expect that the attenuation length of the backscatter profiles should be comparable to the remineralization length of the organic particle flux. The strong decrease in echo below the echo strength peak suggests a rapid consumption of sinking organics and therefore short remineralization lengths below the ODL



Oxygen concentrations at 200 m depth. Purple indicating near zero concentrations. Note location of Oxygen Deficient Zones off Peru and Mexico.



Oxygen profiles in the ETNP oxygen deficient zone showing range from 0 to 18 µmol O_2/L, with concentrations close to cero between 100 and 900 m depth.

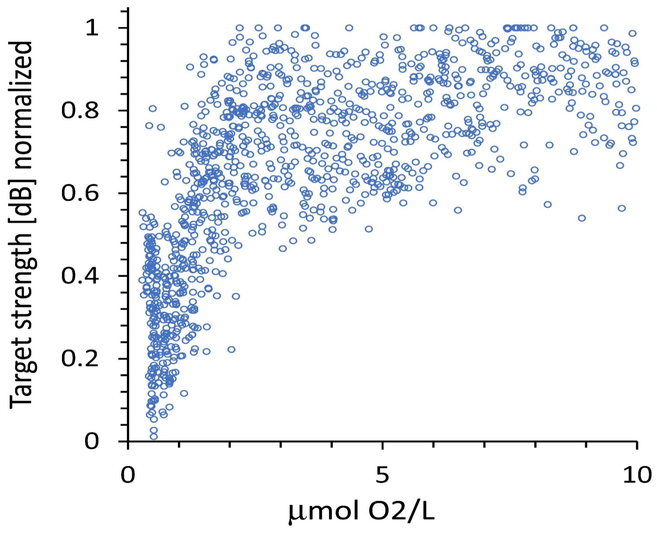


300 kHz LADCP echo profiles [dB] in the Eastern Tropical North Pacific oxygen minimum zone. Daylight profiles in red, nighttime profiles in blue. Note the strong peak between 800 and 1000 m.

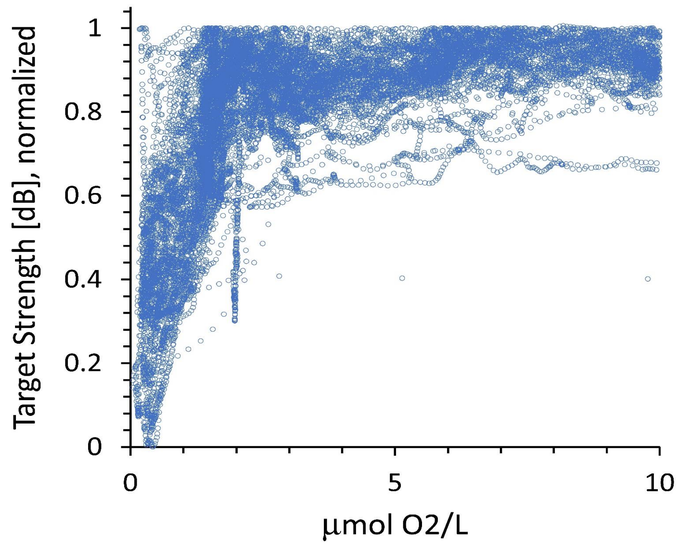
ETNP, MEXICO

ETSP, PERU

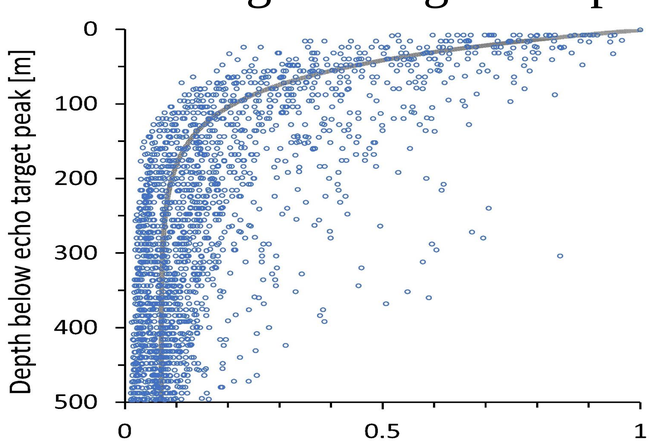
Formation of echo target peak below the lower oxycline at very low oxygen concentrations



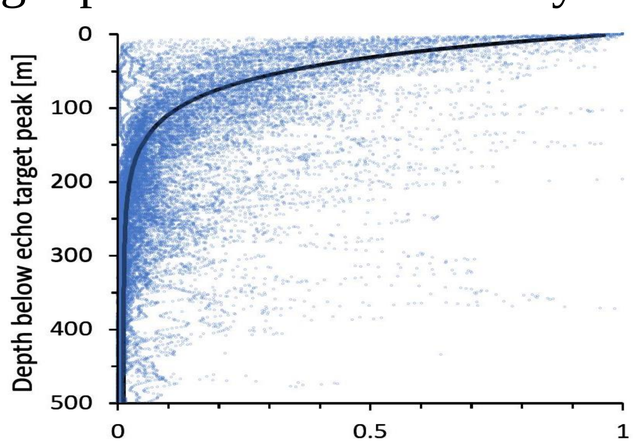
The 300 kHz acoustic echo is close to background in the lower part of the mesopelagic oxygen deficient layer (ODL). ETNP and ETSP (Paulmier et al. 2021) both show a strong peak in echo strength below the ODL. The peak is reached at depth of less than 5 µmol O_2/L



Acoustic target strength is rapidly decreasing with depth below the echo strength peak near the lower oxycline



We assume the echo target strength is proportional to metazoan biomass and metazoan biomass is proportional to the flux of particulate organics. Attenuation depths of echo targets and flux are similar in ETNP: 53 m and ETSP: 46 m



Interpretation: Both ETNP and ETSP behave similar in that the oxygen deficit layer (ODL) reduces little the flux of organic particles between the upper and lower oxycline, therefore the residual flux below the lower oxycline allows to sustain a significant population of metazoans. The echo peak of these microaerobic metazoans is found at depths with oxygen concentrations of only a few µmol O_2/L. Below the peak of the echo target the echo strengths decreased rapidly indicating a proportional loss of metazoans. The e-folded attenuation depths are very low, only around 50 m.

Conclusion: Regions with mesopelagic ODLs increase the sequestration of surface carbon, transporting the carbon efficiently to the lower oxycline which could retain the return of this carbon to the surface order of magnitude a 100 years. Below the ODL the organic carbon particles are rapidly consumed by metazoans within a small depth interval which suggests that the ODL regions do not support an increased organic carbon deposit on the seafloor which would lead to long carbon sequestrations times.

References*:* Paulmier et al. (2021) High-Sustained Concentrations of Organisms at Very low Oxygen Concentration Indicated by Acoustic Profiles in the Oxygen Deficit Region Off Peru. Front. Mar. Sci. 8:723056. doi: 10.3389/fmars.2021.723056