Oceans on a Habitable Planet Spring ‘25

Oxygen Variability in the Southern California Bight (SCB)

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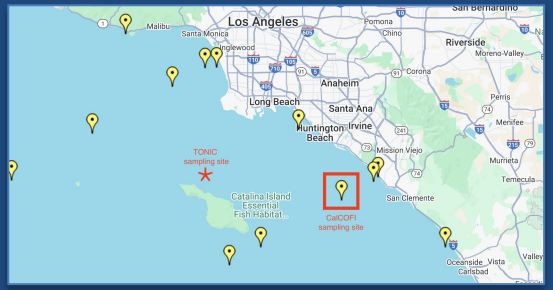
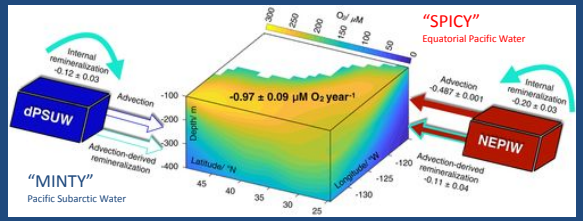
Graphical Abstract



CalCOFI station positions



Drivers of SCB deoxygenation, from Evans et al. (2020)

Abstract

The oxygen content of water in the SCB has decreased by up to 21% since 1984 (Bograd et al., 2008) or roughly 1 uM per year (Evans et al. 2020). To investigate the mechanisms driving this trend, O_2 concentration and spiciness data from the California Cooperative Oceanic Fisheries Investigations (CalCOFI) were analyzed (Line 90, Station 30). Results show a possible correlation between high spiciness (warm, salty water) and low O_2 concentrations ($R^2 = 0.46$), which may suggest the influx of low-oxygen water from the Equatorial Pacific Oxygen Minimum Zone (OMZ).

Background

- O_2 concentration in the SCB has been observed to be decreasing over the past 50 years (Bograd 2008, Keeling 2010, Evans 2020), one possible explanation is the influx of Pacific Equatorial Water via the California Undercurrent, which can be traced with “spiciness” derived from available CalCOFI data.
- **Spiciness** is a state variable defined to be most sensitive to isopycnal thermohaline variations–it increases with temperature and salinity (Flament 2002), and can thus indicate the equatorial origins of SCB subsurface waters.
- **CalCOFI** is a long-term oceanographic and marine system monitoring and research program. Their stations have provided data on biogeochemical properties of the water column in the SCB since 1984, which were used in this investigation.

Key Finding

The CalCOFI data shows an inverse correlation between spiciness and O_2 concentration, suggesting the observed O_2 decrease may be driven by the influx of “spicy”, low-oxygen water from the Equatorial Pacific.

Future Work

These findings can be further augmented with the analysis of longer time series, more CalCOFI stations, and biogeochemical markers like N*.

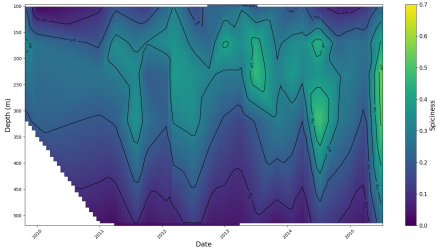


Fig. 1 Temporal variations in spiciness interpolated with depth

Plot shows interpolated spiciness data between depths of 100 m to 500 m from 2010 to 2015, demonstrating what appears to be seasonal variability.

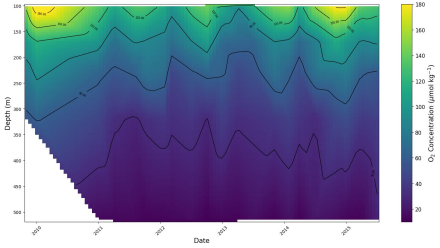


Fig. 2 Temporal variation of oxygen concentration interpolated with depth

Plot shows interpolated oxygen data between depths of 100 m to 500 m from 2010 to 2015, the variations appear to follow the trends exhibited in Fig. 1.

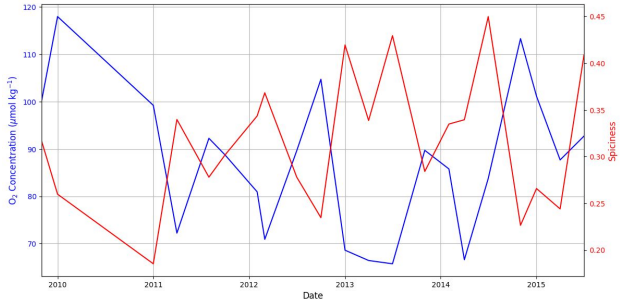
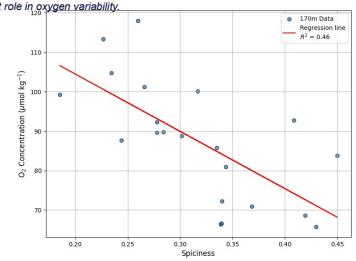


Fig 3. & Fig 4. Temporal variations in Spiciness and Oxygen Concentration are anti-correlated at 170m

Results suggest that that spiciness and oxygen concentration exhibit an inverse relationship and similar periodicity, suggesting that the advection of low-oxygen water from the OMZ in the Equatorial Pacific possibly plays a significant role in oxygen variability.



Flament, P. (2002). *A state variable for characterizing water masses and their diffusive stability: Spiciness.* Ocean Science, University of Hawaii at Manoa.

Keeling, Ralph F., Arne Körtzinger, and Nicolas Gruber. "Ocean Deoxygenation in a Warming World." *Annual Review of Marine Science*, vol. 2, 2010, pp. 199–229.

Bograd, S. J., C. G. Castro, E. Di Lorenzo, D. M. Palacios, H. Bailey, W. Gilly, and F. P. Chavez (2008), Oxygen declines and the shoaling of the hypoxic boundary in the California Current, *Geophys. Res. Lett.*, 35, L12607

Evans, N., Schroeder, I. D., Pozo Buil, M., Jacox, M. G., & Bograd, S. J. (2020). Drivers of subsurface deoxygenation in the southern California Current System. *Geophysical Research Letters*, 47, e2020GL089274. https://doi.org/10.1029/2020GL089274

Data from California Cooperative Oceanic Fisheries Investigations (CalCOFI)