The combined effects of acidification and hypoxia along the west coast of North America

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Ocean Acidification and Hypoxia

The continental shelf waters off the North American West Coast are exposed to water with increasing concentrations of anthropogenic CO₂ (Canthro) from exchanges with the atmosphere. We used a multiple linear regression approach to determine the spatial variations of Canthro in the California Current Ecosystem based on cruise data sets from 2007, 2011, 2012, 2013 and 2016. Our results show significant horizontal, vertical and temporal gradients in Canthro in surface and subsurface waters along the coast, in which Canthro increases at a rate of ~1 µmol kg⁻¹ yr⁻¹ in surface waters, and the rates decrease to values of ~0.3 µmol kg⁻¹ yr⁻¹ at depths near 400 m. Carbon chemistry data from the West Coast of North America have also been compared with similar data from the northern Gulf of Mexico to demonstrate how future changes in CO₂ emissions will impact coastal waters affected by respiration-induced hypoxia (<62 µmol kg⁻¹ O₂). In surface waters, the percentage change in the carbon parameters due to increasing CO₂ emissions are very similar for both regions even though the absolute decrease in aragonite saturation is much higher in the warmer waters of the Gulf of Mexico. However, in subsurface waters the changes are enhanced due to the differences in the initial surface water oxygen concentrations and the changes in the buffer capacity (i.e., increasing Revelle Factor) with increasing remineralized CO₂, with the largest impacts on pH and CO₂ partial pressure (pCO₂) occurring in the colder waters. As anthropogenic CO₂ concentrations begin to build up in subsurface waters, the increased atmospheric CO₂ will expose organisms to hypercapnia (>1000 µatm pCO₂) within subsurface depths. This study demonstrates how different biological thresholds (hypoxia, CaCO₃ undersaturation, hypercapnia) will vary asymmetrically by location and with increasing atmospheric CO₂.