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

R.A. FEELY[1], B. CARTER[2], N. BEDNARSEK[3], W.-J. CAI[4], S.R. ALIN[1], R.R. OKAZAKI[2], AND D. GREELEY[1]

[1]NOAA Pacific Marine Environmental Laboratory, Seattle, WA 98115 USA (correspondence: Richard.A.Feely@noaa.gov)
[2]Joint Institute for the Study of the Atmosphere and Ocean, University of Washington, Seattle, WA 98195 USA
[3]Southern California Coastal Water Research Project, 3535 Harbor Blvd., Suite 110 Costa Mesa, CA 92626 USA
[4]School School of Marine Science and Policy, University of Delaware, College of Earth, Ocean, and Environment, 111 Robinson Hall, Newark, DE 19716, USA

Ocean Acidification and Hypoxia

The continental shelf waters off the North American West Coast are exposed to water with increasing concentrations of anthropogenic CO_2 (C_{anthro}) from exchanges with the atmosphere. We used a multiple linear regression approach to determine the spatial variations of C_{anthro} 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 C_{anthro} in surface and subsurface waters along the coast, in which C_{anthro} 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 CO_2 emissions will impact coastal waters affected by respiration-induced hypoxia (<62 µmol kg^{-1} O_2). In surface waters, the percentage change in the carbon parameters due to increasing CO_2 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 CO_2, with the largest impacts on pH and CO_2 partial pressure (pCO_2) occurring in the colder waters. As anthropogenic CO_2 concentrations begin to build up in subsurface waters, the increased atmospheric CO_2 will expose organisms to hypercapnia (>1000 µatm pCO_2) within subsurface depths. This study demonstrates how different biological thresholds (hypoxia, $CaCO_3$ undersaturation, hypercapnia) will vary asymmetrically by location and with increasing atmospheric CO_2.