SCCWRP #1207

Biogeochemical variability in the California Current System

Curtis Deutsch[2], Hartmut Frenzel[2], James C. McWilliams[1], Lionel Renault[1], Faycal Kessouri[1,3], Evan Howard[2], Jun-Hong Liang[4], Daniele Bianchi[1], Simon Yang[1]

[1]*Department of Atmospheric and Oceanic Sciences, University of California, Los Angeles, CA*
[2]*University of Washington, School of Oceanography, Seattle, WA*
[3]*Southern California Coastal Water Research Project, Costa Mesa, CA*
[4]*Department of Oceanography & Coastal Sciences, College of the Coast & Environment, Louisiana State University, LA*

ABSTRACT
The biological productivity and diversity of the California Current System (CCS) is at the leading edge of major emerging climate trends, including hypoxia and acidification. We present results from a hindcast simulation (reanalysis) of an eddy-resolving oceanic physical-biogeochemical model of the CCS, to characterize its mean state and its patterns and drivers of variability in marine biogeochemical and ecosystem processes from 1995 to 2010. This is a companion paper to a physical analysis in Renault et al. (2021). The model reproduces long-term mean distributions of key ecosystem metrics, including surface nutrients and productivity and subsurface O_2 and carbonate undersaturation. The spatial patterns of Net Primary Productivity (NPP) are broadly consistent with measured and remotely sensed rates, and they reflect a predominant limitation by nitrogen, with seasonal and episodic limitation by *Fe* nearshore in the central CCS, and in the open ocean northern CCS. The vertical distribution of NPP is governed by the trade-off between nutrient and light limitation, a balance that reproduces and explains the observed spatial variations in the depth of the deep *Chl* maximum. The seasonal to interannual variability of biogeochemical properties and rates is also well captured by model simulations. Because of the prevailing nutrient limitation, fluctuations in the depth of the pycnocline and associated nutricline are the leading single factor explaining interannual variability in the interior biogeochemical state, and the relationships between density and biogeochemical rates and tracers are consistent between model and observations. The magnitude and relationship between density structure and biogeochemical processes is illustrated by the 1997–98 El Niño event, which faithfully reproduces the single largest deviation from the mean state in the simulated period. A slower decadal shoaling of the pycnocline also accounts for the concomitant trends in hypoxic and corrosive conditions on the shelf. The resulting variability is key to understanding the vulnerability of marine species to oceanic change, and to the detection of such changes, soon projected to exceed the range of conditions in the past century.