Coupling O_2/Ar and Triple Oxygen Isotope Distribution with Estimates of Vertical Transport to Constrain Biological Production in the Coastal Ocean

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In the last decade, O_2/Ar ratios and the triple oxygen isotope composition (TOI) of dissolved O_2 has been measured in many regions to simultaneously estimate net (NOP) and gross oxygen production (GOP) in the surface ocean. Both of these can be stoichiometrically related to carbon production and therfore, the NOP/GOP ratio reflects the efficiency of an ecosystem to export, rather than recycle, organic carbon. This approach has been limited in regions with strong vertical transport because transport is often difficult to determine. This is especially an issue when the majority of biological production occurs beneath the surface mixed layer. In this study, we combine profiles of the concentration and isotopic composition of oxygen with concurrent estimates of upwelling velocity and eddy diffusivity, based on a mass balance for ^{7}Be ($t_{1/2}$=53d). Mass balances for oxygen are based on a 1-D, non-steady state, two-box model of the upper ocean at the San Pedro Ocean Time-series (SPOT) in Southern California, with observations of both tracers at ~two week intervals used to constrain model parameters. During Spring 2013, upwelling velocities ranged from 0.5 to 3.0 m d^{-1} at SPOT, delivering nutrients which supported GOP rates of 184 to 727 mmol m^{-2} d^{-1} and NOP rates of up to 198 mmol m^{-2} d^{-1}, which translates to Net Community Production (NCP) in the euphotic zone of up to 142 mmolC m^{-2} d^{-1}. NOP/GOP ratios reached up to 0.45 and peaked prior to the maximum in upwelling velocity and GOP. Organic carbon export during spring months, measured in sediment traps set at 100m combined with a water column ^{234}Th budget, ranged from 3.3 to 21.4 mmolC m^{-2} d^{-1}. Export followed a temporal trend similar to NCP in the euphotic zone, but were ~4x smaller due to remineralization above the traps. Results show that it is possible to apply the dissolved O_2/Ar and TOI tracer pair to estimate production rates along the ocean margins, the most productive regions of the worlds oceans.