Mapping the spatial variability of plankton metabolism using nitrate and oxygen sensors on an autonomous underwater vehicle

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ABSTRACT: It is now possible to make highly resolved vertical (<1 m) and horizontal (3 m at constant depth and ~400 m when undulating from surface to 100 m) measurements of nitrate concentration in the upper ocean using sensors deployed on propeller-driven autonomous underwater vehicles (AUVs). The ability to make such highly resolved measurements opens the possibility of detecting small-scale anomalies in nutrient fields that are created by locally high rates of primary production. We employed an in situ ultraviolet spectrophotometer optical nitrate sensor and Sea-Bird oxygen sensor mounted on the Monterey Bay Aquarium Research Institute Dorado AUV to investigate the spatial variability of nitrate and oxygen in Monterey Bay, California. The Dorado conducts missions up to 100 km in length. A very simplified diffusion and reaction model for nitrate, ignoring horizontal processes and advection and assuming steady state, would require that consumption rate = $K_z \times \delta^2 NO_3^- / \delta Z^2$ (K_z = vertical eddy diffusion coefficient). Water column regions exhibiting elevated nitrate uptake rates are identified from anomalies in the second derivatives of the vertical concentration profiles relative to the second derivative of conservative properties. The relationship between chlorophyll *a* fluorescence and the inferred productivity rates exhibits coherent spatial variability across the bay.

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