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Primary Research Paper

A method to estimate net community metabolism from profiles of dissolved O_2 and N_2

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Abstract

A method to estimate net community metabolism (NCM) in natural waters using vertical profiles of water temperature, salinity, dissolved O_2, gas tension, and calculated dissolved N_2 is presented. The method utilizes the disparate biological activity of dissolved O_2 and N_2 to estimate metabolism at different depths in the water column. For well-mixed surface waters, N_2 saturation levels are assumed to be the result of a quasi steady state balance of net warming or cooling and air–water gas exchange. Dissolved O_2 levels are assumed to maintain a similar balance, subject to net biological activity, and NCM is then calculated based on the difference between N_2 and O_2 saturation levels and the estimated timescale required to equilibrate the layer with the atmosphere. For deeper stratified layers of water that warmed after layer formation in isolation from the atmosphere, the temperature at formation is calculated using the measured N_2 concentration and an assumed N_2 saturation level of 100% at formation. By assuming that initial N_2 and O_2 saturation levels were equal, the initial O_2 concentration is calculated based on solubility relationships. NCM of the deeper waters is then estimated based on this information and knowledge of the general seasonal heating cycle of the waters. Daily mean water temperature and dissolved gas levels are used in the calculations. The method was assessed using profile measurements collected at Long Pond, Plymouth, Massachusetts, USA, on 23 August 2002. Oxygen was supersaturated relative to N_2 by approximately 4% in the 0–6 m deep epilimnion, and undersaturated relative to N_2 by approximately 7% in the stratified water at 9 m depth. The estimated 4-day average NCM for the epilimnion was 140 ± 70 mgC $m^{-2}day^{-1}$. For waters at 9 m depth, the temperature at formation was calculated to be 6.58 °C, and the estimated 100-day average NCM was -2.5 ± 0.6 mgC m^{-3} day^{-1}. An independent estimate of -4.6 ± 0.9 mgC m^{-3} day^{-1} was derived from the measured O_2 decline at 9 m depth over the same period of 2003.

Introduction

Net community metabolism (NCM) of natural waters is defined here as the difference between community production, *P*, and respiration, *R*, over a specified period of time. If NCM is positive, production exceeds respiration and therefore the waters are net autotrophic. If NCM is negative, respiration exceeds production and the waters are net heterotrophic. The magnitude and sign of NCM varies with time, water depth, solar radiation intensity, nutrient availability, species composition, and many other physical, biological, and chemical processes. Estimates of NCM at different