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Assessing pelagic and benthic metabolism using free water measurements

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Abstract

Automated in situ sensors for measuring changes in dissolved oxygen (DO) at high frequency have facilitated estimates of gross primary production (GPP) and respiration (R) in aquatic systems. Lake researchers usually rely on a single sensor for these estimates, but such point measurements may miss important spatial heterogeneity in within-lake processes and may not accurately represent systemwide values of metabolism. Here we combine simultaneous measurements of metabolism using DO sensors along transects from the shore to the center of a lake with a spatial model to better understand the underlying heterogeneity in processes contributing to whole-lake epilimnetic metabolism. We use this model to achieve better estimates of epilimnetic GPP and R and to determine the relative contributions of benthic-littoral vs. pelagic processes to these estimates. We compared the spatially explicit process-based model to estimates of metabolism from both a single sensor at the lake's center and a spatially explicit averaging of multiple sensor sites. Estimates of both GPP and R varied on average 2.5- to 3.2-fold from site to site within the same lake, whereas variations were sometimes as high as 6- to 7-fold. Estimates of GPP and R near the perimeter of lakes were on average greater than measurements in the middle of the lake. Our model estimates that benthic-littoral processes accounted for ~40% of epilimnetic GPP and R. A single, centrally located sensor often misses a significant component of this benthic metabolism and accounts for only ~81% of lakewide GPP and R.