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Free-water lake metabolism: addressing noisy time series with a Kalman filter

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Abstract

Whole-ecosystem metabolism is often estimated in lakes using high frequency free-water measurements of dissolved oxygen (DO) taken in the upper mixed layer. DO dynamics in the metalimnion are not adequately captured by measurements made in the upper mixed layer, which could reduce the accuracy of whole-lake metabolism estimates made from such data. However, estimating metabolism from metalimnetic DO time series can be challenging because of high variability (noise). This study used simulated and field data to determine if metabolism estimates from metalimnetic data containing noise can be improved by accounting for both process and observation error in models. When DO time series exhibited high variability, free-water metabolism estimates obtained using a Kalman filter (which accounts for both process and observation error) were substantially more accurate than estimates obtained from models that did not account for error or accounted for process error only.