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Multiple approaches to estimating air-water gas exchange in small lakes

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Abstract

The rate of gas exchange between air and water is an essential quantity in a number of contexts, from mass balances to the calculation of whole-system metabolism. The exchange of a gas between water and the atmosphere is controlled by differential partial pressures of gases in air and in water (both straightforward to measure) and by the amount of turbulent energy exchange between the air-water interface, the measurement of which is neither simple nor direct. This physical exchange is often expressed as a piston velocity (k). We compared four methods for estimating k in a series of small (0.3 to 45 ha), low-wind (mean wind < 3 m s^{-1}) lakes: 1) floating chambers using ambient CH_4; 2) whole-lake SF_6 additions; 3) three wind-based models from the literature; and 4) C mass balances constrained by whole-lake ^{13}C additions. All of the methods, with the exception of one wind-based model, converged on values for k_{600} of between 0.35 and 0.74 m d^{-1} with no biases among methods. The floating chambers, if designed properly, are a cost-effective way of obtaining site-specific values of k for low wind lakes over fairly short time frames (hours).