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Difficulty in Discerning Drivers of Lake Ecosystem Metabolism with High-Frequency Data

James J. Coloso,[1,3]* Jonathan J. Cole,[2] and Michael L. Pace[1]

[1]*Department of Environmental Sciences, University of Virginia, 291 McCormick Rd, Charlottesville, Virginia 22904, USA;* [2]*Cary Institute of Ecosystem Studies, P.O. Box AB, Millbrook, New York 12545, USA;* [3]*Department of Biological Sciences, University of Notre Dame, 263 Galvin Life Sciences Center, Notre Dame, Indiana 46556, USA*

Abstract

High-frequency measurements are increasingly available and used to model ecosystem processes. This growing capability provides the opportunity to resolve key drivers of ecosystem processes at a variety of scales. We use a unique series of high-frequency measures of potential predictors to analyze daily variation in rates of gross primary production (GPP), respiration (R), and net ecosystem production (NEP = GPP − R) for two north temperate lakes. Wind speed, temperature, light, precipitation, mixed layer depth, water column stability, chlorophyll *a*, chromophoric dissolved organic matter (CDOM), and zooplankton biomass were measured at daily or higher-frequency intervals over two summer seasons. We hypothesized that light, chlorophyll *a*, and zooplankton biomass would be strongly related to variability in GPP. We also hypothesized that chlorophyll *a*, CDOM, and temperature would be most strongly related to variability in R, whereas NEP would be related to variation in chlorophyll *a* and CDOM. Consistent with our hypotheses, chlorophyll *a* was among the most important drivers of GPP, R, and NEP in these systems. However, multiple regression models did not necessarily include the other variables we hypothesized as most important. Despite the large number of potential predictor variables, substantial variance remained unexplained and models were inconsistent between years and between lakes. Drivers of GPP, R, and NEP were difficult to resolve at daily time scales where strong seasonal dynamics were absent. More complex models with greater integration of physical processes are needed to better identify the underlying drivers of short-term variability of ecosystem processes in lakes and other systems.

Key words: lake metabolism; gross primary production; ecosystem respiration; net ecosystem production; chromophoric dissolved organic matter; high-frequency data; ecosystem drivers; multiple regression.