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Regulation of spatial and temporal variability of carbon flux in six hardwater lakes of the northern Great Plains

Finlay, K., P. R. Leavitt, B. Wissel, Y. T. Prairie

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ABSTRACT: Six hard-water lakes were sampled May-August for 14 yr in a 52,000 km² catchment to identify the mechanisms that regulate the spatial and temporal variability of net atmospheric exchange of CO₂ of lakes on the Northern Great Plains. Annual mean daily fluxes ranged from -100 to >200 mmol C m⁻² d⁻¹, while pCO, values varied between 0.3 and 5500 Pa. We observed periods of net CO,2 uptake (1995, 2000) and release (1998, 2006) resulting in synchronous variations in net CO, flux among lakes. Furthermore, pCO, pH, and chemical enhancement of CO, influx all varied coherently among sites. Interannual variation in net CO, flux and pCO, was correlated strongly with pH, correlated weakly with other physical and chemical conditions, and was uncorrelated to algal biomass, productivity, or ecosystem respiration. In contrast, spatial variability of watercolumn pCO, was correlated negatively to concentrations of soluble reactive phosphorus, total dissolved nitrogen, pH, and gross primary productivity, suggesting an important role of lake metabolism at large spatial scales. Finally, comparison with an additional 20 saline lakes demonstrated that changes in mean annual pH, pCO₂, and CO₂ flux during 2002-2007 were coherent in diverse lakes within a region of >100,000 km² and suggest that climatic control of pH and pCO2 had an unexpectedly great effect on net CO2 flux through productive hard-water lake ecosystems.

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