Regulation of spatial and temporal variability of carbon flux in six hard-water lakes of the northern Great Plains

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

Limnol. Oceanogr., 54(6_part_2), 2009, 2553-2564 | DOI: 10.4319/lo.2009.54.6_part_2.2553

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 CO_2 of lakes on the Northern Great Plains. Annual mean daily fluxes ranged from -100 to >200 mmol C m^{-2} d^{-1}, while pCO_2 values varied between 0.3 and 5500 Pa. We observed periods of net $CO_2$2 uptake (1995, 2000) and release (1998, 2006) resulting in synchronous variations in net CO_2 flux among lakes. Furthermore, pCO_2, pH, and chemical enhancement of CO_2 influx all varied coherently among sites. Interannual variation in net CO_2 flux and pCO_2 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 water-column pCO_2 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, pCO_2, and CO_2 flux during 2002-2007 were coherent in diverse lakes within a region of >100,000 km² and suggest that climatic control of pH and pCO_2 had an unexpectedly great effect on net CO_2 flux through productive hard-water lake ecosystems.