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Magnitudes and controls of organic and inorganic carbon flux through a chain of hard-water lakes on the northern Great Plains

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ABSTRACT: Whole-lake carbon (C) mass-balance budgets were constructed for a chain of six hard-water lakes to quantify the relative importance of organic carbon (OC) and inorganic carbon (IC) exchanges between atmosphere, water column, sediments, and rivers. Mean summer C fluxes were calculated for each lake during the ice-free periods (May to September) of 1995-2007 by measuring deposition of IC and OC in lake sediments, export of C to outflow rivers, lotic C influxes, and atmospheric exchange of CO2. Unlike soft-water lakes, IC in rivers accounted for 68.2-85.6% of total C (TC) influx to these hard-water lakes, CO_2 efflux accounted for 0-44.5% of total C export (median 2.8%), and sedimentation buried similar amounts of OC and IC. Deposition of C in sediments accounted for 1.8-61.7% of total export and was correlated to water residence time, while C efflux through rivers accounted for 32.6-98.2% of total export, mainly as IC (69.6-85.1% of TC). Unexpectedly, estimates of net ecosystem production based on OC mass balances suggested that all lakes were autotrophic (production > respiration) during summer, despite elevated dissolved organic carbon content (5.6-16.1 mg C L^{-1}), pCO_2 values, and net CO2 emissions to the atmosphere from three lakes. We conclude that C fluxes within and among these hard-water lakes are regulated by hydrologic inputs of dissolved IC rather than by lake metabolism, IC and OC pathways are only loosely coupled, and future climate variability will alter C fluxes in similar lakes mainly through regulation of mass transfer from land.

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