Effect of Surface and Subsurface Flow Networks on Spatial Variation in Ecosystem Processes of Lakes of the Northern Highlands, WI, USA

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In the Northern Highlands region of Wisconsin, USA, a dense network of surface and subsurface flows connects thousands of lakes in a groundwater-dominated flow regime. The behavior of a given lake is influenced both by lake-specific characteristics such as size and shape, as well as its position within a chain of lakes connected by groundwater and surface flows. Yet the broad-scale impact of such networks is little understood in all but a handful of well-studied lakes in the region. We asked how the surface and subsurface flow networks connecting lakes affect the spatial patterns of carbon and water cycling by developing a simulation model representing each of 7500 connected water bodies across the 3500 km2 region. Results indicate that surface and subsurface spatial networks constrain the patterns of water and carbon cycling at multiple scales across the region. Whether a lake produces surface drainage or is a groundwater flow-through lake influences water residence time and carbon cycling traits, and this varies across the landscape by both network and lake-specific characteristics. Lakes exert varying degrees of leverage in each network, potentially differing in their importance to the spatial variation of water flow and carbon processes of the region. These results will inform our broad-scale understanding of the influence of networks on spatial variation of process rates and stocks, as well as contribute to a better understanding of the relative roles of in-lake and between-lake processes in this lake-rich region.