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The influence of topography and vegetation self-organization over resource fluxes in wetland ecosystems

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While it is recognized that topography and vegetation self-organization (SO) are both first order controls over ecosystem dynamics, the discrete contributions that these two controls have over ecosystem functioning have not been studied in any rigorous way. This work is focused on systematically isolating the separate and combined impacts of topography and SO over vegetation dynamics. We simulate the steady state and transient dynamics of nitrogen-limited patterned peat vegetation observed in the bogs of northern Siberia. We do so across a realistic range of land slopes, nutrient limitation values, and rainfall amounts. Simulation results show that on relatively shallow slopes, vegetation SO is a primary control over the spatial arrangement of vegetation, and that such self-organized arrangements yield the most efficient capture of ecosystem resources. However, as slope increases, and or resource limitation is low, topography begins to exert its control over the temporal and spatial dynamics. As will be discussed, these results suggest a simple continuum framework, valid across biomes, for understanding the interplay between these two first order controls. Specifically, as resources (e.g., water, nutrients) increase, ecosystem dynamics shift towards topographic control, while when resources are reduced, ecosystem dynamics shift towards vegetation SO control.