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A predictive framework for coupling Hydrology, Biogeochemistry, and Ecology

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The coupling of hydrological, biogeochemical, and ecological processes at catchment to landscape scale results in observable patterns in ecosystem structure, the amount and chemistry of stream discharge, and landsurface-atmosphere exchanges of energy and biogeochemicals. All of these patterns result from the close coupling of water, energy, carbon, and nutrient cycling, yet rarely are both the vertical (landsurface-atmosphere) and lateral (hydrological residence time and streamflow) exchanges associated with a particular ecosystem structure studied in concert. Our research attempts to bridge this gap by focusing on how ecosystem structure, specifically vegetation, mediates four-dimensional (X,Y,Z, and time) fluxes of water, carbon, and nutrients in semi-arid environments of the southwestern United States. Our generalized approach involves an iterative combination of measurement, modeling, and experimentation where process-level inferences drawn from one research activity are used to develop testable hypothesis for related efforts. Preliminary results have linked spatial variability in hydrologic residence time to seasonal variability in nutrient limitation; spatial and interannual variability in water source with carbon uptake and isotopic signature; vegetation controls on both snow water input and soil moisture; and the importance of alluvial aquifers in stream and river biogeochemistry.