River Corridor Hydrobiogeochemistry from Reaction to Basin Scale

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The Pacific Northwest National Laboratory (PNNL) Subsurface Biogeochemical Research (SBR) Science Focus Area (SFA) will transform understanding of spatial and temporal dynamics of coupled hydrologic and biogeochemical processes in river corridors (hydrobiogeochemical function) from reaction to watershed and basin scales, thus enabling mechanistic representation of river corridor processes and their response to disturbances in multiscale models. Rivers serve as integrators of watershed processes as their composition and dynamics reflect the conditions of the surrounding landscapes and subsurface environments. Hydrologic exchange flows (HEFs) between river channels and surrounding sediments are a ubiquitous feature of river corridors but vary substantially in their character and impacts. HEFs and the biogeochemical activities they promote are a critical component of river corridor hydrobiogeochemical function, yet we lack transferable understanding of how governing processes vary through space, time, and across scales. Furthermore, the representation of river corridors in basin-scale integrated land surface models is currently limited, and their cumulative impacts on watershed function are poorly understood. Accordingly, it is difficult to predict how river corridor hydrobiogeochemistry will respond to future disturbances. Our team is developing mechanistic understanding of the processes that link hydrologic, geochemical, and microbial processes in river corridors and integrating that new knowledge into numerical models at scales from fundamental reactions to major river basins to enable robust prediction. Wildfires and modified precipitation regimes are key disturbances that influence river corridor hydrobiogeochemistry and are prevalent in the Columbia River Basin (CRB). To elucidate the impacts of these disturbances, and working toward the vision stated above, we will expand our scope to span the CRB and, in collaboration with other SBR SFAs, other major basins across the contiguous United States. We will use a distributed, open science approach based on our successful development of WHONDRS to develop regional and national partnerships that will underpin this research. A multiscale ModEx approach will integrate process-based and data-driven models with experiments and observations across reaction to basin scales in coupled iterative learning cycles. Connecting project outcomes to the efforts of other agencies will ultimately enable robust watershed predictions to facilitate the solution of national challenges in water quality/quantity and Earth System prediction.