Poster #175

Cumulative Effects of River Corridor Hydrobiogeochemical Processes on Watershed Functioning

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This element aims to assess cumulative effects of river corridor hydrobiogeochemistry on nutrient (N, C) balance at reach and watershed scales, and quantify the relative contributions of large mainstem river corridors to watershed scale nutrient budgets. We will develop a first-of-kind river corridor model capable of representing hydrologic exchange fluxes (HEFs) and associated biogeochemical processes guided by high-resolution mechanistic model simulations. This new river corridor model will be coupled with other existing watershed model components to create a prototype watershed-scale modeling framework that directly accounts for river corridor hydrobiogeochemistry in predictions of watershed-scale nutrient processing, water quality, and ecosystem health. In previous research, we have established a coupled modeling framework featuring the coupling of the subsurface flow and reactive transport code PFLOTRAN and the Community Land Model (CLM) for studying interactions among groundwater–surface water–land surface processes. We also collected hydrogeological, riverine, land surface, and hydro-climatic datasets along the Hanford Reach and beyond, and assessed the role of water management activities, such as reservoir operation, on regulating river discharge along the Hanford Reach. Built upon these efforts, we will couple three models representative of river corridor processes: subsurface flow and reactive transport (PFLOTRAN), land surface processes (CLM), and river flow and transport (i.e., the routing model in the Soil and Water Assessment Tool [SWAT] or SWATR hereafter) enhanced with hydromorphology-based models of hydrologic exchange and reaction potential (i.e., the physically-based Networks with EXchange and Subsurface Storage or NEXSS). A new version of NEXSS will be created to incorporate a detailed hydromorphic classification scheme and estimates of HEFs and residence time distributions based on mechanistic model results. SWATR will be modified to incorporate a multi-rate transient storage model and reactions. In parallel to model development, cumulative effects of hydrologic exchange flows and river corridor biogeochemistry on watershed-scale nutrient processing will be evaluated by conducting numerical experiments in the Upper Columbia-Priest Rapids watershed using SWAT with and without river corridor HEFs. The modeling of HEFs and associated biogeochemical processes will be enabled by the coupled SWATR-NEXSS model. This will lay the foundation for applications of the prototype coupled watershed modeling framework. The proposed model development activities will benefit greatly from the fundamental knowledge regarding river corridor HEFs and biogeochemistry derived from mechanistic models and observations from other research elements. Meanwhile, our research team will collaborate with the DOE IM^3 SFA to leverage their developments in watershed-scale modeling with reservoir impoundments.