Integrated Modeling of Carbon and Nitrogen Cycling in River Corridors Across the Yakima River Basin

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Project: PNNL River Corridor SFA (RCSFA)
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Project Abstract: *This element of the PNNL SFA seeks to quantify the cumulative impacts of river corridor hydrologic exchange flows (HEFs), dissolved organic matter (DOM) chemistry, and microbial activity on biogeochemical cycling, water quality, and contaminant mobility across the Yakima River Basin (YRB) under both baseline and disturbance conditions.* River corridors play important roles in carbon and nitrogen cycling and removal of excess nutrients. We are developing a new approach to mechanistically represent the river corridor as an integral part of a watershed using unstructured meshing in ATS, seamlessly linking dynamic river flow processes and heterogeneous terrestrial inputs. Leveraging ATS-PFLOTRAN coupled through the Alquimia interface from the IDEAS-Watersheds software ecosystem, we performed coupled hydrologic and biogeochemical modeling at the American River watershed to investigate water, energy, and solute fluxes across the river-groundwater interface in connection to variations in land use, hydrogeology, climate, and disturbances. The biogeochemical hot spots and hot moments within the river corridors are found to be strongly influenced by riverbed properties and flow conditions. SWAT models are set up across the Yakima River Basin (YRB) to study how watersheds respond to wildfires of various burn severity and history. The simulated water quantity and water quality responses (e.g., water temperature, suspended solids, total nitrogen and total phosphorous) are used to guide where we perform sampling and monitoring within the YRB to improve the predictive understanding of fire impact. Machine learning methods have been applied to integrate data from USGS river gauges and remote sensing to improve model parameterization and calibration. By exploring interactions among these three watershed response variables, i.e., streamflow, evapotranspiration and snow cover, for calibrating the ATS model at the American River Watershed, we found that remotely sensed ET data products might provide as useful information as the streamflow for watershed model calibration in cases where stream gage data are unavailable. Our approach can be generalized beyond the YRB and applied to other basins facing environmental disturbances and water challenges of national significance.