Pacific Northwest National Laboratory SFA: Hydro-Biogeochemical Process Dynamics in the Groundwater-Surface Water Interaction Zone

PNNL SFA (Laboratory Research Manager: Charlette Geffen)

John Zachara*[1] (PI; john.zachara@pnnl.gov), Jim Fredrickson[1] (Co-PI), Tim Scheibe[1] (Co-PI), Xingyuan Chen[1], Glenn Hammond[2], Maoyi Huang[1], Chongxuan Liu[1], Chris Murray[1], Hyun-Seob Song[1], and James Stegen[1]

[1]*Pacific Northwest National Laboratory, Richland, WA*
[2]*Sandia National Laboratories, Albuquerque, NM*

The PNNL SFA is developing a predictive understanding of the groundwater-surface water interaction zone (termed the subsurface interaction zone, SIZ). Research explores linkages with the water cycle and incorporates hydrologic impacts on fundamental biogeochemical and ecological processes into a multiscale modeling framework that forecasts system responses and feedbacks to environmental changes. The SIZ is a ubiquitous and biogeochemically active domain at the groundwater-surface water interface that regulates contaminant releases to surface waters and associated carbon and nitrogen cycling. A key aspect of our research is the performance of observational, experimental, and computational science on contaminant, carbon, and nitrogen transformation dynamics in the SIZ within the context of an integrative multiscale modeling approach. This approach will enable bi-directional (up- and down-scale) transfer of knowledge, process models, and parameters to the desired scale of prediction. Using the 75 km Hanford Reach of the Columbia River as our overall field site, overarching research questions are driven down from the reach scale to focus lower-scale scientific hypotheses on essential system attributes, behaviors, or mechanisms for robust process model development. A facies-based, multiscale simulation framework is being established to connect biogeochemical transport models across scales while preserving robust process descriptions derived at local field sites along the Hanford Reach and with field derived sediments in the laboratory. New microbial ecological models are being formulated and tested to translate microbial community composition and function into biogeochemical process rates dependent on environmental conditions. Our research on the subsurface interaction zone will provide essential knowledge and relevant models for rivers worldwide that flow through glacio-fluvial aquifers and for high latitude/elevation catchments with coarse-grained sediments that are vulnerable to climate change.