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The effect of surface-groundwater interaction on dissolved organic carbon transformation

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The preservation and improvement of water quality in streams is a challenging task, limited by our partial understanding of the coupling between biogeochemical and hydrological processes occurring in stream ecosystems. High potential for biogeochemical activity is found in the hyporheic zone, the saturated sediments where surface water and ground water mixes and degradation activities occur. The aim of the study was to quantifythe effect of losing and gaining flow conditions on the degradation of dissolved organic carbon (DOC). Experiments were conducted in a recirculating flume that is equipped with a drainage system that enables the control on losing and gaining fluxes. The degradation of DOC under losing and gaining conditions was studied by spiking the water with benzoic acid and monitoring the decrease in DOC concentration in the bulk water over time using an online UV/Vis spectrophotometer. In addition, the spatial and temporal change in oxygen concentrations within the benthic biofilm was measured using a Clark-type oxygen microelectrode. Preliminary results showed that DOC degradation rate was faster under higher overlying water velocity, due to enhanced delivery of DOC to the biofilm. Under both gaining and losing conditions, the DOC degradation was slower than under neutral condition, probably as a consequence of the reduction of the hyporheic exchange zone. Series of oxygen profiles under losing conditions showed a complete depletion of oxygen within the first 3 millimeters of sediment. In contrast, oxygen profiles under gaining condition showed a incomplete consumption of oxygen (usually within 1 mm), followed by an increase in the concentration of oxygen deeper in the sediments due to the upward flow of oxygenated groundwater. The results suggest that the size of the active aerobic region within the hyporheic zone is changing dynamically with the flow conditions. The effect of flow conditions on redox zonation in the hyporheic zone is expected to affect a myriad of important reactions and ecological processes and should be incorporated on future models.