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Numerical modeling of the nitrogen retention and turnover at the surface-subsurface interface of riffle-pool sequences

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Quantification of the retention and turnover of constituents in the hyporheic zone of rivers and streams is very challenging as a result of complex physical and biogeochemical processes. There is a tremendous potential of using processes based numerical models to advance our understanding of hyporheic processes. The presentation aims at the calibration and validation procedure for the NH4 and NO3 profiles at various section of a reach and specification of parameters of major significance among large number of parameters involved in the modeling procedure. A case study was conducted on a riffle-pool sequence of the river Lahn, Germany. Using the hydrodynamic TELEMAC2D model, the surface water profile was calibrated. The groundwater flow model, MODFLOW with its reaction module RT3D, was used for the analysis in the subsurface. The first order reaction module was coded for NH4-NO3-N2 conversion process. The water surface elevation data from the hydrodynamic model is integrated into the subsurface flow and reactive transport model. The measured concentration profile (over depth), at various points of River Lahn were calibrated and parameter sensitivity analysis were performed. The model is found to be highly sensitive to hydraulic conductivity, reaction parameters, specific storage, and longitudinal dispersivity; moderately sensitive to conductance; and slightly sensitive to specific yield and molecular dispersion coefficient. It was found that the beginning of the riffle is the location of the highest concentration gradient. The locations of highest hydraulic gradient as a result of morphological change (riffle), is the location of the highest water exchange and nitrogen transformation. In spite of uncertainties involved in the process-based models (data, parameters, and model structure) valuable conclusions can be made towards focused theoretical and experimental studies for new process understating. There is a need to improve the process based numerical models in a more sophisticated manner by stronger coupling of the surface and subsurface process, with due consideration the difficulties in data acquisition and parameter estimation.