Comprehensive Estimation of Solute Transport and Interaction in Surface-Subsurface Hydrologic System using the Linked SWAT-MODFLOW-RT3D Model

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Abstract. Integrated modeling of surface and subsurface hydrology is a crucial tool for assessing the impact of land management practices on water yields and agricultural chemical fate and transport in complex watersheds. Of the existing watershed models, the Soil Water and Assessment Tool (SWAT) has been used extensively for analysis of water resources in watersheds of varying scale and complexity. However, application of the model is limited in groundwater flow and solute transport due to current SWAT processes do not account for the geographic source of groundwater and the possible complex groundwater flow pathways caused by spatially-varying aquifer characteristics. In this study, the SWAT model is linked with the groundwater flow model MODFLOW and a groundwater solute reactive transport model RT3D (Reactive Transport in 3 Dimensions) to provide a watershed model that simulates not only land surface and in-stream hydrologic, biological, and nutrient processes, but also flow and reactive solute transport in the aquifer and groundwater-surface water interactions. An application of the SWAT-MODFLOW-RT3D to the Sprague River Watershed in Upper Klamath River Basin, southern Oregon, United States, also is presented, with certain hydrologic simulations (e.g., stream and groundwater discharge, and water tables' comparison) and chemical reactions (e.g., nitrate concentrations in stream and groundwater). According to the results, the in-stream nitrate loadings displayed by the SWAT-RT3D model matched well with the observed field data, especially for capturing the baseflows, compared to the SWAT simulation. Apart from that, the average-yearly-spatial-distribution exhibited that nitrate is mainly concentrated along the river the study region.