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SWAT+/MODFLOW: a new model for simulating surface-subsurface hydrological processes at the watershed scale

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Abstract: The Soil & Water Assessment Tool (SWAT), one of the most widely used watershed models worldwide to simulate hydrological and nutrient transport processes, has recently been restructured to improve code development, analysis, and spatial representation of elements and processes in watersheds. In this study, we present a new surface-subsurface flow model that links this new version of SWAT, called SWAT+, with MODFLOW. Following the basic linking procedure of the recently developed SWAT-MODFLOW model, SWAT+ hydrologic response units (HRUs) and sub-basins are spatially related to MODFLOW grid cells to enable mapping of recharge, evapotranspiration, and groundwater/surface water exchange between SWAT+ and MODFLOW. Due to the restructuring of the SWAT+ code, the River cells of MODFLOW are included as spatial objects that receive/provide water from/to SWAT+ stream channels. MODFLOW is called as a subroutine within SWAT+, creating a single compiled FORTRAN code. The code structure is much more efficient than the previous SWAT-MODFLOW code, allowing for ease of future code development. The use of the SWAT+/MODFLOW model is demonstrated for the Little River Experimental Watershed (Georgia) and the Middle Bosque Watershed (Texas), with model results tested against groundwater levels and streamflow. As the strength of SWAT+ lies in its spatial representation and linking of elements and processes in watersheds, we envision SWAT+/MODFLOW to be used primarily in watersheds with a large degree of human management, i.e. via reservoirs, canals, groundwater wells, drains, etc.

Keywords: SWAT, SWAT+, Groundwater, Groundwater-Surface Water Interactions