**Quantification of groundwater fluxes in the Upper Colorado River Basin using the *SWAT+gwflow model***

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**Abstract.** The Upper Colorado River Basin (UCRB) contributes to 90% of the streamflow in the Colorado River, with over half derived from groundwater discharge into streams. However, persistent drought, compounded by anticipated climate change, necessitates accurate hydrological forecasting for effective water resource management. We utilize the Soil and Water Assessment Tool Plus (SWAT+) model, augmented with the *gwflow* module, to conduct physically based, spatially distributed surface water and groundwater modeling across 60 8-digit watersheds in the UCRB from 2000 to 2015. Our approach simulates surface and subsurface flows, groundwater-surface water interactions, reservoir dynamics, and various hydrological fluxes, including floodplain interactions, agricultural groundwater pumping, and canal seepage. Each cultivated field is treated as a distinct hydrological response unit, with its unique irrigation source, i.e., stream, aquifer, or reservoir. Results reveal significant spatial heterogeneity and varied watershed responses across the basin to changing climate variables. These findings serve as a foundation for predicting future streamflows, groundwater levels and storage, and fluxes under different climate change scenarios. Our findings will guide adaptive water management strategies, including conservation efforts, groundwater abstraction and recharge initiatives, and the determination of environmental flow requirements. This study underscores the importance of integrating surface water and groundwater modeling for informed decision-making and the formulation of sustainable water management policies in the face of climate change challenges in the UCRB.