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Modelling the impact of climate change on regional hydrological processes in a data-scarce mountainous region

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Water resources are essential to the ecosystem and social economy worldwide, especially in the desert and oasis of the Tarim River Basin (with an area of 1,102,000 km2), whose headwater originates from the Tienshan and Kunlun Mountains. This basin is characterized by complicated hydrologic processes while scarce meteorological observations. In this study, we analyzed the impact of climate change in Tarim River Basin through an integrated hydrological model SWAT (Soil and Water Assessment Tool). Important hydrologic processes were identified spatially through a multiple objective (global) sensitivity analysis approach, and the model was calibrated through a multiple objective optimization, with long term observed flow data at 32 stations. The calibrated model was then used to analyze the spatial distributed hydrologic response to climate change through future climate forcing obtained by applying BMA (Bayesian Model Averaging) technique to an ensemble of 21-GCM (General Circulation Model) simulations from the Coupled Model Intercomparison Project Phase 5 (CMIP5) under RCP4.5 and RCP8.5. Results indicate: 1) sub-watersheds in the catchment can be divided into several groups: groundwater dominated, snowmelt controlled, surface-water influenced, or combined; 2) the use of large-scale, physically-based hydrological models together with the multi-objective sensitivity analysis and optimization enables consistent and comprehensive examination of the dominant hydrological processes of each headwater of the Tarim River; 3) runoff shows an overall increasing trend in the near future but will decrease at the end of the 21st century. The integrated models provided robust information for the water resources management in the Tarim River Basin and served as a basis for assessment of the impact of climate change on future water availability.