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Improving hydrological model performance by incorporating dynamic variability of parameters

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Extensive research is being carried out in developing new calibration procedures for improving the efficacy of hydrologic models. Considering the simulation period into separate wet and dry periods, and performing discrete calibration on each of them has resulted in improvement in model performance, especially during dry periods. In this procedure, it is envisaged that by splitting the time period into wet and dry, the temporal variability of soil moisture, which play a major role in maintaining the water balance of the catchment, is accounted. The discretely calibrated data is then recombined to form the entire time series. However, while recombining the discretely calibrated time periods, the physics of the hydrological processes, at the time of transition from one period to the other, may show abrupt variations. In addition, the short spells of wetness and dryness within this partitioned period, which influences the soil saturation, may not get effectively simulated. This study proposes division of simulation period into wet and dry spells considering the state of saturation of the watershed. This is achieved by clustering the time series of the data using the antecedent precipitation and the soil moisture conditions. A supervised Gustafson-Kessel clustering technique is employed for the same. Subsequently, a relationship between the precipitation, the daily change in soil moisture and a selected model parameter is established for all the cluster transitions and incorporated into the model structure. The proposed methodology is tested using a grid based model with six parameters, on Riesel watershed, Texas, USA. The results indicate that clusters formed are unique, with no fixed duration and no repetitive patterns across the entire simulation period. For preliminary analysis, only one parameter is dynamically varied depending on the incoming rainfall. The performance of the refined model (NSE = 0.85) over the conventional static parameter model (NSE = 0.83), though not significant, indicate that better process representation can aid in improving model simulations. It is noted that this method eliminates the abrupt variation of soil moisture across the wet and dry periods, as the simulation is continuous.