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Identification of the HYPE hydrological model over the Indian subcontinent

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Large-scale hydrological modelling has the potential to encompass many river basins, cross regional and international boundaries and represent a number of different geophysical and climatic zones. However the performance of this type of model is subject to several sources of uncertainty/error which may be caused by, among others, the imperfectness of driving inputs, i.e. regional and global databases. This uncertainty further leads to wrong model parameterisation and incomplete process understanding. Data assimilation aims to utilize both hydrological process knowledge (as embodied in a hydrologic model) and information that can be gained from observations; hence information from model predictions and observations is synergistically used to improve performance. This study presents a methodology, drawn on experience from modelling with the HYPE model in the Indian subcontinent (covering a modelled area of 4.9 million km^2), to enhance identification of highly parameterised large-scale hydrological models. The model was set up using available large-scale datasets on topography, land use, soil, precipitation, temperature, lakes, reservoirs, crop types, irrigation, evaporation, snow and discharge. A stepwise automatic calibration is carried out to avoid, to a certain extent, errors incurring in some model processes and being compensated by introducing errors in other parts of the model. In addition, information from remote sensing data is assimilated in the model to drive identification of parameters that control the spatial distribution of potential evapotranspiration. Results show that despite the strong hydro-climatic gradient over the domain, the model can adequately describe the hydrological process in the Indian subcontinent. Overall, the median Kling-Gupta Efficiency (KGE) increased from 0.08 to 0.64 during the calibration process using 43 stations of monthly discharge series over the period 1971 to 1979. Finally, decomposition of the KGE (i.e. into terms describing agreement in correlation, bias and variability between observed and modelled streamflow series) allowed a thorough understanding of model inadequacies.

Keywords

Large-scale hydrological modelling, HYPE, model identification, Kling-Gupta Efficiency, remote sensing, India