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India Water Model: A Transboundary Water Modeling System Over South Asia and a 75-year Daily Streamflow Reanalysis

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Streamflow has a crucial role in the global water cycle. The demand for long-term daily streamflow observations becomes essential for robust water resources planning, hydroclimatic extremes analysis, and informed ecological assessments. However, there is a lack of availability of this type of dataset, particularly concerning the river basins of South Asia daily. The hydrologic-hydrodynamic model can simulate the streamflow over the domain. However, these models are not well calibrated to provide the locally relevant streamflow simulation daily. In response to this crucial knowledge deficit, in this study, we developed a state-of-the-art hydrological-hydrodynamic model to simulate daily streamflow spanning the years 1949 to 2022 across river basins South Asia by calibrating the model with observed daily streamflow. Leveraging meteorological observations meticulously gathered by the India Meteorological Department (IMD) inside India, and Modern-Era Retrospective Analysis for Research and Applications, Version 2 (MERRA2) outside domain, our model integrates the Noah MP as the land surface model and the HyMAP routing model to generate intricate daily streamflow dynamics within the South Asian sub-continental river basins. We calibrated the model at the 173-gauge stations against observed streamflow over South Asia. The calibration and validation time periods were 3 and 5 years respectively. This process ensures the adaptability and relevance to the local nuances of Basins in the model, aligning the simulated daily streamflow patterns with observed data. A comprehensive examination of the model's performance provides good results, with key metrics such as Kling-Gupta Model Efficiency (KGE), coefficient of determination (R2), and Nash-Sutcliffe efficiency (NSE) consistently exceeding a median threshold of 0.34. Taking our analysis further, we calculated the KGE skill score of the dataset, we found that 83/173 in calibration and 72/173 in validation showed KGE skill score more than 0.08. This extensive reconstruction and evaluation of streamflow dynamics not only contribute significantly to filling the knowledge gap but also lay the foundation for more precise and informed water management strategies in the dynamic landscape of South Asia's river basins.