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Enhancing Large-Scale Hydro-Climate Services Through a Regionalized Machine Learning Approach

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Local observations can drive machine learning (ML) based post-processors for improving hydrological model accuracy and reliability, and further ensuring that model outputs represent the local hydrological conditions. However, post-processing large-scale hydrological models is not straightforward and remains particularly challenging in ungauged basins. This study presents an ML-based post-processing approach which allows streamflow regionalization based on the hydrological characteristics of the river systems. We employed Long Short-Term Memory (LSTM) models to tailor the simulated streamflow obtained from the E-HYPE hydrological model to local observations across the pan-European domain. Here, we took advantage of the European hydrologically similar regions identified in Pechlivanidis et al. (2020), while LSTM was trained to map the simulated and observed runoff for each hydrologically similar cluster. The catchments in each cluster were divided into training and testing datasets under a K-fold cross validation approach. We compared the raw and post-processed simulations using different evaluation metrics capturing general bias (Mean Absolute Error), high flows (Nash-Sutcliffe Efficiency; NSE), and low flows (log-NSE). The results indicate that the regionalized LSTM approach enhances the hydrological model performance, evidenced not only at the stations incorporated within the training set, but also at those excluded from the training set. Overall, this study highlights the potential of ML in post-processing hydrological model outputs, especially in ungauged basins, setting a promising framework for AI-enhanced large-scale hydro-climate services.

References

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