The influence of different objective functions in GR4J model-on-model performance for streamflow forecasting application

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Abstract: WaterNSW supplies bulk water to its customers and operates a large network of dams and rivers of NSW. For operations, we use the river system models within CARM that are based on daily and hourly scales for river operations, and flood and storage operations. These models use deterministic approaches for streamflow predictions rather than probabilistic framework. Considerable advances in probabilistic risk-based hydrologic and hydroclimate modelling have been made in research and operational settings over the last decade nationally and overseas (Bennett et al., 2014; McInerney et al., 2020). We investigate the performance of daily GR4J model with the choice of different objective functions for use in probabilistic forecasting. GR4J model is chosen for its effectiveness in real-time operational forecasting applications, owing to its simplicity, computational efficiency, and lower data requirements. It has also been tested and used in many streamflow forecasting agencies in France, Australia, and other countries. The three objective functions chosen for this investigation include SDEB (Square-root Daily, Exceedance and Bias) in Source (eWater) generally used for river system planning models, NSE-BC0.2 (Nash-Sutcliffe Efficiency with Box-Cox Transformation set to 0.2) in the Multi-Temporal Hydrological Residual Error (MuTHRE) model used for seasonal streamflow forecasts, and NSE-SCHEF in SWIFT (Short-term Water Information and Forecasting Tools) used for 7-day streamflow forecasts. We investigate how well the three objective functions perform using a deterministic performance evaluation criterion covering low-, medium- to high-flow range. Seven catchments in Lachlan, Namoi Peel and Murrumbidgee are selected for this investigation. A leave-one-year-out cross-validation approach is implemented for all the seven catchments. Some of the typical results are provided in Figure 1 for reference. The choice of objective functions significantly affects performance of the model for simulating higher or lower flows. NSE_SCHEF leads to a better fit to the observed moderate and high flows, and the timing of observed large flow events. NSE_BC02 gives a better performance on low flows. SDBE does a greater job in reproducing the observed flow volume. This investigation addresses the sensitivity of model performance to the choice of different objective functions in order to provide useful recommendations for the strategy going forward with probabilistic simulations and forecasting in operational model development.

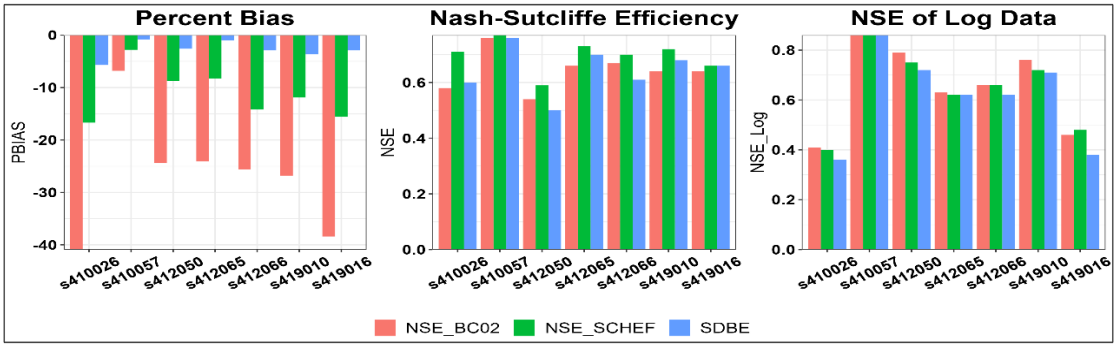

Figure 1. Illustration of model performance across seven catchments and three objective functions

REFERENCES

Bennett, J., Robertson, D., Shrestha, D.L. et al. 2014. A System for Continuous Hydrological Ensemble Forecasting (SCHEF) to lead times of 9 days. Journal of Hydrology, 519, 2832–2846.

McInerney, D., Thyer, M., Kavetski, D., et al. 2020. Multi-temporal hydrological residual error modeling for seamless subseasonal streamflow forecasting. Water Resources Research, 56, e2019WR026979.

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