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Practical guidance on representing the heteroscedasticity of residual errors of hydrological predictions

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Appropriate representation of residual errors in hydrological modelling is essential for accurate and reliable probabilistic streamflow predictions. In particular, residual errors of hydrological predictions are often heteroscedastic, with large errors associated with high runoff events. Although multiple approaches exist for representing this heteroscedasticity, few if any studies have undertaken a comprehensive evaluation and comparison of these approaches. This study fills this research gap by evaluating a range of approaches for representing heteroscedasticity in residual errors. These approaches include the 'direct' weighted least squares approach and 'transformational' approaches, such as logarithmic, Box-Cox (with and without fitting the transformation parameter), logsinh and the inverse transformation. The study reports (1) theoretical comparison of heteroscedasticity approaches, (2) empirical evaluation of heteroscedasticity approaches using a range of multiple catchments / hydrological models / performance metrics and (3) interpretation of empirical results using theory to provide practical guidance on the selection of heteroscedasticity approaches.

Importantly, for hydrological practitioners, the results will simplify the choice of approaches to represent heteroscedasticity. This will enhance their ability to provide hydrological probabilistic predictions with the best reliability and precision for different catchment types (e.g. high/low degree of ephemerality).