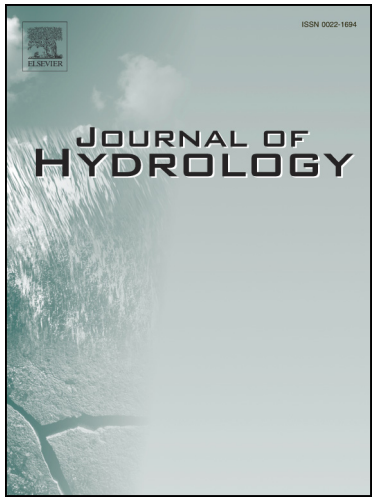

Research papers

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Multivariate Bias Corrections of Mechanistic Water Quality Model Predictions

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Abstract: Water quality networks usually do not include observations on a continuous timescale over a long period. Statistical models that use streamflow and mechanistic models that use meteorological information and land-use are commonly employed to develop continuous streamflow and nutrient records. Given the availability of long meteorological records, mechanistic models have the potential to develop continuous water quality records, but such predictions suffer from systematic biases on both streamflow and water quality constituents. This study proposes a multivariate bias correction technique based on canonical correlation analysis (CCA) - a dimension reduction technique based on multivariate multiple regression - that reduces the bias in both streamflow and loadings simultaneously by preserving the cross-correlation. We compare the performance of CCA with linear regression (LR) in removing the systematic bias from the SWAT model forced with precipitation and temperature for three selected watersheds from the Southeastern US. First, we compare the performance of CCA with LR in removing the bias in SWAT model outputs in predicting the observed streamflow and total nitrogen (TN) loadings from the Water Quality Network (WQN) dataset. We also evaluate the potential of CCA in removing the bias in SWAT model predictions at daily and monthly time scales by considering the LOADEST model predicted loadings as the predictand for CCA and LR. Evaluation of CCA with the observed dataset and at daily and streamflow time scales shows that the proposed multivariate technique not only reduces the bias in the cross-correlation between streamflow and loadings, but also improves the joint probability of estimating observed streamflow and loadings. Potential implications of the proposed bias-correction technique, CCA, in water quality forecasting and management are also discussed.

Keywords: multivariate; bias correction: mechanistic models; water quality modeling

1 Introduction

Water quality measurements available over a continuous period are usually limited to watersheds that have implemented monitoring programs for tracking water quality impairments under the US Clean Water Act of 1972 (PUBLIC LAW 92-500). Cost and labor requirements limit these daily continuous observations to shorter time periods, i.e. 1-2 years, from the start time of impairment (Quilbé et al., 2006; Rao et al., 2013). However, studies focusing on the regional and long-term variability of nutrient loadings to climate have been limited to smaller sample lengths and sparse sampling for interpreting and calibrating water quality models (Smith et al., 1997). Data sources having multi-decadal observations such as the U.S. Geological Survey National Stream Water-Quality Monitoring Network