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A top-down framework for watershed model evaluation and selection under uncertainty

T. Wagener, Y. Bai, and P. Reed

Pennsylvania State University, Civil and Environmental Engineering, University Park PA, United States
(thorsten@engr.psu.edu, +1-(0)814-8637304)

This study introduces a top-down strategy for model evaluation and selection under uncertainty in which watershed model structures with increasing complexity are applied to twelve watersheds across a hydro-climatic gradient within the United States (US). The models' complexities and their related assumptions provide an indication of the dominant controls on the watershed response at the inter-annual, intra-annual, monthly, and daily time scales as captured in the water balance signatures (or metrics) used in this study. The ability of the models to capture the water balance signatures is evaluated in an ensemble framework with respect to their reliability (Is the model ensemble capturing the observed signature?) and with their shape (Is the model structure capable of representing an observed signature's variability?). Model selection is automated by combining the reliability and shape performance measures in a fuzzy rule system. Our results suggest that the framework can be tuned to function as a screening tool that formalizes our model selection process. This fuzzy model selection framework enhances our ability to automatically select parsimonious model structures for large databases of watersheds and therefore provides an important step towards understanding how controls on the watershed response vary with landscape and climatic characteristics. This understanding further advances our ability for model-based watershed classification.