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Structural uncertainty in reservoir operations models: a benchmark study across CONUS

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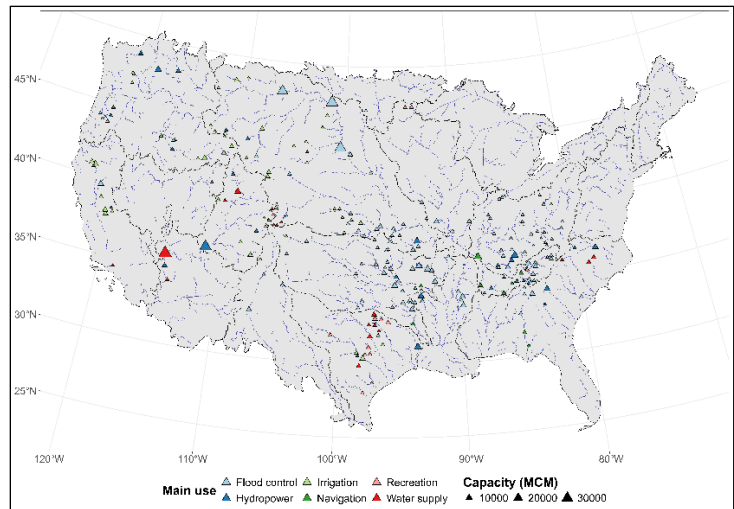
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Abstract:

Human activities substantially alter the hydrological cycle, yet their representation in hydrological models remains limited. Reservoir management is among the most influential interventions. In the contiguous United States (CONUS) alone, more than 52,000 dams provide storage capacity equivalent to 75% of the mean annual runoff, underscoring the need for improved modeling approaches. To quantify the uncertainty associated with alternative reservoir representations, we conduct a benchmark study across 250 reservoirs in CONUS, selected from the *ResOpsUS* dataset based on data availability for the 1990–2015 period. Multiple release policies, grouped into three main categories (generic, data-driven, and optimization-based), are implemented within a common reservoir simulation framework that accounts for key processes such as evaporation. This design enables a systematic assessment of the accuracy and limitations of these reservoir representations and their suitability under varying conditions (e.g., reservoir purpose, size, input data requirements, or operational data availability and quality). Model performance is evaluated by comparing simulated and observed release and storage time series for each policy. Results show that the choice of reservoir management representation significantly affects prediction accuracy, with potential cascading impacts on the calibration and simulation of hydrological processes.

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