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Process-based model evaluation of cold region hydrological processes

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Model simulations of hydrological processes are critical for applications in streamflow forecasting and water security assessments. In this work, we develop a model-agnostic benchmarking framework to evaluate the fidelity of continental-domain model simulations. The benchmarking framework includes (1) synthetic test cases to evaluate the implementation of the model equations; (2) process-based diagnostics in research basins to evaluate model representations of individual processes; and (3) continental-domain benchmarks to evaluate the fidelity of large-domain model simulations. As a test case, we use simulations from the Structure for Unifying Multiple Modeling Alternatives (SUMMA) configured across the North America domain. We rely on existing theory about cold-region hydrologic processes and large-domain observations of these processes to define process-specific evaluation metrics. These process diagnostics provide insights in our current ability to model cold region hydrological processes across the North America domain.