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Towards a controlled sensitivity analysis of model development decisions

Martyn Clark (1) and Bart Nijssen (2)

(1) National Center for Atmospheric Research, Research Application Laboratory, Boulder, United States (mclark@ucar.edu),
(2) University of Washington, Seattle, Washington, United States

The current generation of hydrologic models have followed a myriad of different development paths, making it difficult for the community to test underlying hypotheses and identify a clear path to model improvement. Model comparison studies have been undertaken to explore model differences, but these studies have not been able to meaningfully attribute inter-model differences in predictive ability to individual model components because there are often too many structural and implementation differences among the models considered. As a consequence, model comparison studies to date have provided limited insight into the causes of differences in model behavior, and model development has often relied on the inspiration and experience of individual modelers rather than a systematic analysis of model shortcomings.

This presentation will discuss a unified approach to process-based hydrologic modeling to enable controlled and systematic analysis of multiple model representations (hypotheses) of hydrologic processes and scaling behavior. Our approach, which we term the Structure for Unifying Multiple Modeling Alternatives (SUMMA), formulates a general set of conservation equations, providing the flexibility to experiment with different spatial representations, different flux parameterizations, different model parameter values, and different time stepping schemes. We will discuss the use of SUMMA to systematically analyze different model development decisions, focusing on both analysis of simulations for intensively instrumented research watersheds as well as simulations across a global dataset of FLUXNET sites. The intent of the presentation is to demonstrate how the systematic analysis of model shortcomings can help identify model weaknesses and inform future model development priorities.