A FRAMEWORK FOR EVALUATING THE NET IMPACT OF ALGORITHM DECISIONS ON HYDROLOGICAL MODEL OUTPUT: NUMERICAL AND CONCEPTUAL ABSTRACTIONS

James Craig, University of Waterloo, 519-888-4567 x37554, jrcraig@uwaterloo.ca

1. James R. Craig, University of Waterloo
2. Andrew P. Snowdon, University of Waterloo

The proliferation of lumped and distributed surface water models is extensive: over seventy such models are used in both research and practice. This abundance of models is partially a function of the wide variety of methods that can be used to represent individual components of the hydrologic cycle. In most models, fluxes of mass and energy between various storage units (e.g., soil, snow, or canopy) are estimated as a function of the current state and properties of the system, using any number of algorithms and empirical relationships. Even the most 'physically-based' process models use a representation of these fluxes that is highly dependent upon both the scale and character of the system. In addition, these sub-models are fed with measured data such as temperature and incoming solar radiation, which must be somehow distributed to the finest spatial resolution of the model, corrected for local conditions such as elevation, albedo, and aspect. From interpolating rainfall to calculating snowmelt to routing streamflow, the number of specific decisions hard-coded into any individual surface water model is considerable, and these structural decisions impact the model robustness, validity, appropriateness, and portability of model parameters. They likewise can introduce biases, force compensatory calibration of parameters, and encourage unnecessary sensitivity to spatial and temporal discretization choices. Lastly, they make it exceedingly difficult to compare between models in any meaningful fashion. In essence, they impact our ability to be confident in model output.

Perhaps the best way to mitigate the potentially misleading influence of individual model decisions is to provide a framework with which the impact of these decisions can be tested, understood, and adapted to. This approach has been successful in recent investigations into the impact of model structure (e.g., Clark et al., (2008), Framework for Understanding Structural Errors (FUSE): A modular framework to diagnose differences between hydrological models, Water Resources Research, doi:10.1029/2007WR006735). For a more general framework that can address the cumulative impact of any hard-coded model decision, a rigorous abstraction of the functioning of hydrological models in general is necessary. Here, the numerical and conceptual abstraction for the RAVEN hydrological modelling framework is discussed. The framework is demonstrated to successfully emulate existing model results and is used to test the impact of uncertainty in model algorithm choice upon diagnostic output.