Geophysical Research Abstracts
Vol. 13, EGU2011-4175, 2011
EGU General Assembly 2011

The perils of poor numerics in catchment hydrology: On the interplay between temporal data aggregation, time stepping schemes, objective functions and hydrological model reliability

Dmitri Kavetski (1), Fabrizio Fenicia (2,3), and Martyn P. Clark (4)

(1) University of Newcastle, Calllaghan, Australia (dmitri.kavetski@newcastle.edu.au), (2) Centre de Recherche Public – Gabriel Lippmann, Grand-Duchy of Luxembourg, (3) Delft University of Technology, the Netherlands, (4) National Center for Atmospheric Research (NCAR), Boulder, Colorado, USA

This study explores the impact of temporal data aggregation on the quantitative and qualitative behaviour of inferred hydrological model parameters, predictions and their uncertainties. It also examines the impact of the time resolution of the calibration data on the identifiable system complexity, and on the performance of the calibrated models in predictive mode. Experimental data from the Weierbach basin (Luxembourg) is used to infer and analyse a set of conceptual models of varying complexity, over time scales of 30 min to 3 days, using several combinations of numerical implementations and inference equations. In addition to traditional objective functions such as the Nash-Sutcliffe index, we also examine data signatures such as flow duration curves and timings of hydrograph peaks.

Spurious time scale trends arise in the parameter estimates when unreliable time stepping approximations are employed, and/or when the heteroscedasticity of the model residual errors is ignored. In some cases, the impact of model numerics rivals or exceeds that of objective function selection. Yet these maladies are treatable: the use of robust numerics and more adequate (albeit still imperfect) likelihood functions markedly stabilizes the time scale dependencies. Parameters describing slowflow remained essentially constant over the range of sub-hourly to daily scales considered here, while parameters describing quickflow converged towards increasingly precise and stable estimates as the data resolution approached the characteristic time scale of these faster processes.

A key practical finding is that, when robust time stepping schemes are used, higher time resolution enables the identifiability of increasingly complex model structures. Importantly, the predictive ability and consistency of complex models improved substantially when the implicit Euler scheme was employed, whereas the same model hypotheses performed inconsistently when implemented using uncontrolled numerical techniques.

These results are shown to be consistent with theoretical expectations, including numerical error analysis and data-averaging considerations. More broadly, this study provides insights into the information content of data and, through robust numerical and statistical techniques, furthers the utilization of dense-resolution data and experimental insights to advance catchment-scale hydrological process representation.