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Improving prediction uncertainty estimation in urban hydrology with an error model accounting for bias

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Predictions of the urban hydrologic response are of paramount importance to foresee floodings and sewer overflows and hence support sensible decision making. Due to several error sources models results are uncertain. Modeling statistically these uncertainties we can estimate how reliable predictions are. Most hydrological studies in urban areas (e.g. Freni and Mannina, 2010) assume that residuals E are independent and identically distributed. These hypotheses are usually strongly violated due to neglected deficits in model structure and error in input data that lead to strong autocorrelation.

We propose a new methodology to i) estimating the total uncertainty and ii) quantifying different type of errors affecting model results, videlicet, parametric, structural, input data, and calibration data uncertainty. Thereby we can make more realistic assumptions about the residuals.

We consider the residual process to be a sum of an autocorrelated error term B and a memory-less uncertainty term E. As proposed by Reichert and Schuwirth (2012), B, called model inadequacy or bias, is described by a normally-distributed autoregressive process and accounts for structural deficiencies and errors in input measurement. The observation error E, is, instead, normally and independently distributed. Since urban watersheds are extremely responsive to precipitation events we modified this framework, making the bias input-dependent and transforming model results and data for residual variance stabilization.

To show the improvement in uncertainty quantification we analyzed the response of a monitored stormwater system. We modeled the outlet discharge for several rain events by using a conceptual model. For comparison we computed the uncertainties with the traditional independent error model (e.g. Freni and Mannina, 2010). The quality of the prediction uncertainty bands were analyzed through residual diagnostics for the calibration phase and prediction coverage in the validation phase.
The results of this study clearly show that input-dependent autocorrelated error model outperforms the independent residual representation. This is evident when comparing the fulfillment of the distribution assumptions of E. The bias error model produces realization of E that are much smaller (and so more realistic), less autocorrelated and heteroskedastic than with the current model. Furthermore, the proportion of validation data falling into the 95% credibility intervals is circa 15% higher accounting for bias than under the independence assumption.

Our framework describing model bias appeared very promising in improving the fulfillment of the statistical assumptions and in decomposing predictive uncertainty. We believe that the proposed error model will be suitable for many applications because the computational expenses are only negligibly increased compared to the traditional approach. In future we will show how to use this approach with complex hydrodynamic models to further separate the effect structural deficits and input uncertainty.

References

P. Reichert and N. Schuwirth. 2012. Linking statistical bias description to multiobjective model calibration. *Water Resources Research*, 48, W09543, doi:10.1029/2011WR011391.

G. Freni and G. Mannina. 2010. Bayesian approach for uncertainty quantification in water quality modelling: the influence of prior distribution. *Journal of Hydrology*, 392, 31-39, doi:10.1016/j.jhydrol.2010.07.043