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Modeling the behavior of an ungauged catchment using alternative datasets: a case study of the Caribou catchment in Canada

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Abstract:
The modelling of ungauged catchments is a long standing problem in hydrology and there is still no general consensus regarding the best practices to adopt in a variety of situations. In addition to flood and drought forecasting, there are other interests of modelling the hydrological behaviour of a catchment, whether it is gauged or not. For instance, estimation of groundwater recharge can be performed through an integrated modeling of the catchment. In this study, the WaSim model is used to model the hydrology of the Caribou River catchment located in the province of Quebec, in Canada. Since this catchment includes an important aquifer that is used both for drinking water, industrial and potential agricultural purposes, an accurate recharge assessment is important and is the long-term objective of the project. The WaSim model was chosen due to its very versatile soil sub-model features which allow to simulate subsurface flows and calculate the groundwater recharge as an output variable.
Since the Caribou River is ungauged, alternative means of calibrating the free parameters of WaSim had to be implemented. The implementation of a calibration protocol that can get the most out of the few available data is a secondary objective and is the subject of this presentation. First, a « twin » gauged catchment is selected for its physiographic and hydro-climatic similarities with the Caribou River catchment. Streamflow series from this « twin » catchment are then transferred and used jointly with the dynamically dimensioned search (DDS) algorithm (Tolson and Shoemaker 2007) to obtain a raw calibration of the WaSim model parameters. This initial calibration can be further refined using two available datasets: (1) snow water equivalent data interpolated on a 10 km by 10 km grid and (2) a short and discontinuous time series of streamflow obtained using the land-surface scheme of the environmental multiscale atmospheric model (GEM) at Environment and Climate Change Canada and a unit-hydrograph based routing model. The parameters thus obtained are then validated with a few point measurements of streamflow collected at two locations on the Caribou River during a field campaign realized in 2016-2017. The model performance is assessed using the mean absolute error (MAE) and the results show a satisfactory agreement of the WaSim model with the measured values.

References:
Tolson, B. A., and C. A. Shoemaker. 2007. "Dynamically dimensioned search algorithm for computationally efficient watershed model calibration." Water Resources Research 43 (1). doi: 10.1029/2005wr004723.