Geophysical Research Abstracts
Vol. 20, EGU2018-4707, 2018
EGU General Assembly 2018

The calibration problem in hydrological models: a mapping of the cost functions

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The increasing complexity of the hydrological numerical models requires as much complex parameterization, for which calibration procedures are needed. A number of approaches exist in literature, with different cost function to minimize, different classes of local or global optimization algorithms or observations assimilation methods. Such variety of methods also depends on the purposes of the calibration itself: if the models aims to correctly reproduce a multi-years water balance it will require a different approach from the calibration needed in order to provide a good estimates of the extreme floods in a given region. Unfortunately, even when the model of interest is simple, generally at least 3-4 parameters are to be calibrated, leading to a multi-dimensional parameters space to explore in order to minimize the cost function. In this work a simple rainfall-runoff lumped model with 4 parameters is used as toy-model in multiple cases of calibration: different historical series of precipitation and other micrometeorological inputs are used in order to produce the corresponding flows time series. Then, the parameters space of the model is explored on a 4-D regular grid in order to map different possible cost functions of common use (RMSE, Nash-Sutcliff efficiency, etc.) in synthetic cases (i.e. where the cost function admits a 0 value) and in actual observations cases. The results of the mapping are exposed and discussed as possible starting point to optimize the choice of cost-functions and minimization algorithms for hydrological calibration.