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Model independent approach for estimating hydrological model parameters and rainfall time-series using only discharges time-series and coarse data

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Despite hydrological models progressed in terms of relevancy and efficiency, a calibration step is still required to estimate parameters values that can not be obtained by field experiments or other physically based reasoning. As a consequence, hydrological models results robustness depends on data availability and data accuracy. Furthermore, current calibration procedure often require concomitant forcing and prognostic variables time series at identical time step (e.g. hourly rainfall and discharges times series for flood hydrological models) which also limits the applicability of hydrological models (what can be done for retrospective historical analysis, for poorly gauged catchment, etc).

This communication deals with the question of the possibility of hydrological model calibration with less information content. In particular, it will be shown that rainfall and discharge time series are redundant to some extent and at least on the case study presented here (Ardèche catchment, 2000 km2, Southern France).

As a first part, it will be shown that "doing hydrology backward" (Kirchner, 2009) can be generalized to several models based on different and even contradictory assumptions, leading to a model-independent hydrology backward approach. Also, it will be shown that if a model is reasonably set up on a catchment, rainfall time series can be accurately inverted using only discharges time-series. This prefigure the idea that discharges time-series contains both information on rainfall inputs and informations on the discharge-rainfall relationship, i.e. the hydrological behaviour of the considered catchment, and that these coupled informations may be separately identified. In other terms, is it possible to distinguish and to quantify, within the discharges time series, the model parameters values from one side and the rainfall time-series on the other side ? This will be illustrated as a second part. Indeed, presented results will show that, knowing only the hourly time-series and the cumulated areal rainfall, it is possible to estimate accurate parameter values (not significantly different from those obtained by classical calibration step) and accurate hourly rainfall time-series. This was done for three different hydrological models. Results show that identified parameter values identified by inverting discharges time-series are very similar to those obtained by classical calibration technics. Inverted rainfall time-series are also very similar to observed ones, in terms of temporal dynamics and intensities variability.

This approach may raise several perspectives. Can we rebuild historical rainfall time-series and peak rainfall intensities of historical storm events based on coarse data? Can this method contribute to calibration using non-concomitant rainfall-discharges times series? These questions will be also discussed in the presentation.