EGU21-8609
https://doi.org/10.5194/egusphere-egu21-8609
EGU General Assembly 2021

Integration of Hidden Markov States in a hydrological model calibration/validation protocol

Étienne Guilpart[1], Vahid Espanmanesh[2], Amaury Tilmant[3], and François Anctil[4]
[1]Université Laval, Département de génie civil et de génie des eaux, Québec, Canada (etienne.guilpart@gmail.com)
[2]Université Laval, Département de génie civil et de génie des eaux, Québec, Canada (spanmanesh.vahid@gmail.com)
[3]Université Laval, Département de génie civil et de génie des eaux, Québec, Canada (amaury.tilmant@gci.ulaval.ca)
[4]Université Laval, Département de génie civil et de génie des eaux, Québec, Canada (Francois.Anctil@gci.ulaval.ca)

Due to climate changes, the stationary assumption in hydrology has become obsolete. Moreover, the uncertainty regarding the future evolution of the Earth's climate and its impact on flow regimes is still large. Over the last decade, new risk management approaches have been proposed to support water resources planning under deep uncertainty. Those approaches rely at some point on a hydrological model to derive time series of streamflows for various hydro-climatic scenarios. One of the key issue is to make sure that the hydrological model is robust, i.e. that it performs well over contrasted hydro-climatic conditions. The differential split-sample test principle proposed by Klemes in 1986 recommends partitioning the time series into numerous and independent subperiods with different stationary climate features. Then, the hydrological model calibration is achieved on a specific climate period, and the validation on other(s). Classical detection methods commonly used to partition the times series, such as Mann-Kendall test or Pettitt test, can only detect a single change point, and thus are unable to handle complex climate sequences with multiple change points. We propose a calibration/validation protocol of hydrological models which rely on both the differential split-sample test and on an Hidden Markov Model to identify a succession of subsequences in a time series based on the state of the underlying process. We applied the proposed protocol on the Senegal River (West Africa). The hydrological model used is the conceptual GR2M model. Results show that (i) when the river discharges time series does not display a clear climate trend, and have multiple change points, classical rupture tests are not suitable. Hidden Markov Models are a good alternative as long as the climate sub-sequences are long enough (typically around 30 years or more); (ii) including a Hidden Markov Models in such protocol open up the range of possibilities for calibrate/validate, which can lead to an enhancement of the criterion function (but not necessarily).

Klemes, V.: Operational testing of hydrological simulation models, Hydrological Sciences Journal, 31, 13-24, 415 https://doi.org/10.1080/02626668609491024, 1986.