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Clustering model responses in the frequency space for improved flood risk analysis

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Hydrologic models are employed in the flood risk studies to simulate time series of model responses to given inputs. These simulated time series of pseudo-observations can be next statistically analysed and in this way they can extend existing observed records. Simulations of hydrologic models are however associated with modelling uncertainty, often represented through a simulation ensemble with multiple parameter sets. The need of using multiple parameter sets to represent uncertainty is linked however with increased computational costs that may become prohibitive for long-time series and many input scenarios to be analysed. Due to the non-linear input-output relationship in the hydrologic model, a pre-selection of parameter sets is challenging.

This work presents a clustering approach as a tool to learn about the model hydrologic responses in the flood frequency space from the training dataset. Based on this learning process, representative parameter sets are selected that can be directly used in other model applications to derive prediction intervals at much lower computational costs. The study is supported with sensitivity analysis to the number of clusters. Based on results from a small catchment in Switzerland and 10'000 years of streamflow pseudo-observations, it has been found that grouping the full simulation ensemble with 1000 members into 3 to 10 clusters is already suitable to derive commonly applied prediction intervals (90%, 95% or 98%) in the flood frequency space. The proposed clustering approach can be applied in any flood risk analysis to lower the computational costs linked with the use of a hydrologic model.