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Using catchment similarities and flow signatures to evaluate multi-basin models

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Catchments with similar landscape types often generate similar flow signatures and this is normally the underlying assumption in hydrological interpretation and modelling. This presentation will explore the importance of catchment characteristics for hydrological model design, by identifying the most important landscape features and quantifying their impact on model predictions across Europe and in Sweden, respectively. Results from two multi-basin models and their databases have been used in the analysis; one for Europe including 181 gauged catchments (E-HYPE), and one for Sweden including 401 gauged catchments (S-HYPE). Each dataset is based on open data and cover catchments with a wide range in size, large variety of climatological and physiographical regions, and also with anthropogenic impacts from regulations and water abstractions. The model concept is a semi-distributed processes-based approach, using conceptual algorithms and providing daily time-series.
Two different ways to evaluate the importance of catchment similarities in hydrological modelling are presented: 1) For Europe, we produced a simple correlation matrix to explore catchment similarities with several observed and modelled flow signatures, respectively. Modelled flow and observed flow signatures were also correlated. The results were used to evaluate the basic model assumptions and model usefulness when applied in a homogenous way across Europe. 2) For Sweden, we experimented with withdrawal of catchment features from an existing model to reconstruct the change in model performance, when including spatial distributed catchment characteristics and regional calibration of similar catchments. The results indicate which processes that are most dominant for flow signatures, which input data that is most sensitive for model performance and how uncertainties can been reduced most efficiently in this environment.
The two examples show how models can be evaluated to provide more understanding on dominant hydrological processes and basic model assumptions than what is normally achieved from statistical criteria on model performance. The results will give direction for model improvements in the next model versions of the two model domains.