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Structural uncertainty assessment in a discharge simulation model ensemble

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It is a major goal in hydrological modelling to identify and quantify different sources of uncertainty in the modelling process. This paper places emphasis on structural uncertainty of river runoff simulation with different model structures. In this study, the model structure is understood to be composed of two parts - flow processes (perceptual model) and equations (conceptual model). We created a model ensemble with increasing model structure complexity for uncertainty evaluation. It is applied in a distributed runoff model system with the PCRaster modelling language for two study areas: Kielstau - a small lowland basin in northern Germany, and XitaoXi - a mesoscale high mountainous basin in the south of China. Uncertainty is investigated for different levels of model structure complexity and compared at these two study basins. The results show that the model structure is an important factor affecting model performance. The question of 'which model is the most appropriate' is quite case-dependent. The best-performed model achieved NS value of 0.7 (Kielstau) and 0.6 (XitaoXi) respectively. The results also confirm that after a certain level an increase in model structure complexity does not necessarily lead to better simulation. Both case studies indicate that the simulation uncertainty for low-flow period contributes more to the overall uncertainty than for peak-flow period, although the main hydrologic features differ greatly in these two basins.