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The more the merrier? Increasing forecast performance through a hydrological multi-model system over European basins

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Flood forecasting systems with coupled meteorological and hydrological models seldom apply more than one hydrological model although the usage of multiple meteorological models is common. For example, the European Flood Awareness system (EFAS) uses four different NWP systems (ECMWF Ensemble, High resolution, COSMO-GME and COSMO-LEPS) to produce probabilistic forecasts. This study focuses on the added value of using a range of different hydrological models in the context of flood forecasting. The models used were the gridded hydrological model LISFLOOD, the land surface scheme HTESSEL coupled to the flood-plain model CaMa-Flood and the semi-distributed hydrological model E-HYPE. The models were forced with 5 km gridded temperature and precipitation series calculated from observation stations over Europe, and the simulated discharge were compared with a number of runoff stations from the GRDC database. The results indicate that the hydrological models LISFLOOD and E-HYPE outperform HTESSEL, especially for smaller and medium-sized catchments. For the larger catchments, for example Danube, HTESSEL and CaMa-Flood performs better. The runoff from the models were also weighted using Bayesian Model Averaging according to their performance at the observational stations to create a “hybrid” model. The study highlights that using more than one hydrological model increases the robustness of a system as the model uncertainty as well as individual model performance can be used to improve flood forecasting systems.