Uncertainty reduction of climate model projections for hydrologic scenarios

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The uncertainty of projections from climate models can be significant, especially with respect to precipitation. This represents a challenge for decision makers as the spread of the climate model ensemble can be large and, even there can be no consensus on the direction of the climate change signal. This problem is carried through to impact models such as hydrological models. Here, we evaluate different approaches to reduce the uncertainty using 16 Euro-CORDEX Regional Climate Models (RCMs) that drive three different setups of the integrated and distributed MIKE-SHE hydrological model for a catchment in Denmark. Each model is calibrated against an extensive database of hydrological observations (stream discharge, hydraulic head, actual evapotranspiration, soil moisture). We evaluate the skills of the raw and bias-corrected RCMs to simulate precipitation in a historical period using sets of nine, six, five, and three metrics for nine steps. After each step, the lowest-performing model is removed from the ensemble and the standard deviation of the new ensemble is estimated. Subsequently, the uncertainty on the projected groundwater head and stream discharge are evaluated. Based on the evaluation of raw RCM simulations, the largest decrease in the uncertainty of projected discharge (5th, 50th and 95th percentiles) is obtained using the set of five metrics. When evaluating the bias-corrected RCMs, the largest uncertainty reduction in stream discharge is obtained when the set of all nine metrics is considered. Similar results are obtained for groundwater head. The reduction of initial uncertainty is almost a factor of two higher when the evaluation of models is based on bias-corrected compared to raw climate models results. This analysis gives an insight of how different approaches could decrease the uncertainty of future projections for hydrological analyses of the impact of climate change.