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The more is not the merrier – an informed selection of climate model ensembles can enhance the quantification of hydrological change

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Production of a large ensemble of climate simulations suitable for impact assessments is an attempt to enhance our knowledge about the associated uncertainties in future projections. However, the actual quantification of the change in the climate and its impact relies on the ensemble of models selected, particularly given the wide availability of climatic simulations from various initiatives, i.e. CMIP5, CORDEX.

Here, we hypothesize that historical streamflow observations contain valuable information to investigate practices for the selection of climate model ensembles. We apply eight selection methods (based on democracy, diversity of GCM, diversity of RCM, maximum information minimum redundancy, best performing hindcasted climate depiction, best performing hydrological model, simple climate model averaging and reliable ensemble average) to subset an ensemble available from 16 combinations of Euro-CORDEX GCM-RCM by comparing observed to simulated streamflow shift of the Danube from a reference period (1960–1989) to an evaluation period (1990–2014). Simulations are carried out with the well-performing Upper Danube COSERO hydrological model, spanning a calibration and evaluation period of more than 100 years. Comparison against no selection shows that an informed selection of ensemble members improves the quantification of climate change impacts where methods that maintain the diversity and information content of the full ensemble are favourable. In addition, the method followed allows the assessment which individual climate models perform best, where only three of 16 models were able to correctly reproduce the direction of streamflow change in each season.

Prior to carrying out climate impact assessments, we propose splitting the long-term historical data and using it to test climate model performance, sub-selection methods, and their agreement in reproducing the indicator of interest, which further provide the expectable benchmark of near- and far-future impact assessments. This test can further be applied in multi-basin experiments to

obtain a better understanding of uncertainty propagation and uncertainty reduction in hydrological impact studies.