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An assessment of methods to deal with climate change uncertainty – validating the selection of ensemble combinations

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Climate change impact projections depend on which climate data and models are used for the projection. This is a major source of uncertainty in climate change predictions. Many different approaches exist how to deal with these uncertainties through the selection of specific ensemble members. Examples of these ensemble selections are “best-performing climate model(s)” with respect to the representation of historical climate, the “full ensemble median” or a “representative sub-sample of GCMs and RCMs”.

An evaluation which selection is most meaningful has to date not been carried out because the full historical period is commonly used to select combinations, leaving no observations for a validation of the selection. In this study, we split the historical period of streamflow of the Danube in Vienna into a baseline (1960-1989) and validation period (1990-2015). Observed shifts in the seasonal pattern of streamflow from the baseline to the control period clearly exist, with an increase in winter and autumn discharges and decrease in spring and summer. This shift is used as a validation scenario. For assessing which GCM and RCM models and ensembles from the CORDEX initiative perform best, we calculated the streamflow change from all individual models and all their possible ensemble combinations. The seasonal RMSE between simulated streamflow forced by observed climate and simulated streamflow forced by bias-corrected hindcasted climate is used as the performance criteria.

Based on the individual models, our analysis shows a wide range in hindcasted flow changes from baseline to validation period. All possible ensemble combinations span a “feasible region” that describes the range of streamflow change. This range is widest for the ensembles with only 1 member, since each CORDEX climate dataset is treated individually. With an increasing number of ensemble members, the predicted range in streamflow change is becoming narrower since the ensemble median of multiple models cuts off extremes at the upper and lower boundary. Apart from spring, the hindcasted range of changes includes the streamflow changes calculated from observed climate data. For all seasons, the direction of streamflow change is depicted correctly by most climate models. Different published ensemble selection methods are evaluated in the “feasible region” and ranked according to their performance in predicting the observed streamflow change.